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THE TOTAL SOLAR ECLIPSE OF MAY 28, 1900.

By E. Walter Maunder, F.R.A.S.

In one important respect the total eclipse successfully observed in January, 1898, differs from that successfully observed in May, 1900. The first had its sunrise and sunset limits in the inaccessible regions of Central Africa and Western China respectively. Its central or midday portion, however, lay across the Peninsula of Hindustan, so that the observers were comparatively speaking massed together, and their conditions either of time or weather did not greatly differ from each other.

The latter eclipse, on the other hand, had its high noon in mid Atlantic, where there was no convenient island lying in the track from which observers might view the eclipse high in the sky and with the greatest total phase. The observers had perforce to go either to the extreme west, where the shadow track lay across the southern states of North America, or to the extreme east, where stations were available on the *terra firma* of the Peninsula or the northern states of Barbary. Though the sun was in no case very high, and the periods of totality were short, we have in the eclipse just past —since the shadow passed through clear weather from Mexico to Tripoli—the great advantage of being able to compare results, both coronal and spectroscopic, obtained before and after the interval of a few hours. This comparison will be of the utmost value in deciding many points as to the slow or rapid change in the form and direction of the coronal filaments and streamers, but naturally some weeks must elapse before such comparison can be made, and at the moment I can speak only of the observations secured in Algiers and the neighbourhood.

All eclipse observations tend to take on a routine character, and rightly so. No fact, either in the form or the spectrum of the corona, can be completely worked out from the observations of a single eclipse, or even three or four eclipses. Thus, though we may not now expect to make any very startling discovery from the medium-sized photographs of the inner corona, or even from the very large scale ones, yet it is necessary that these should be taken regularly and in considerable numbers at each eclipse. It is from the permanence or the variation in their minor details that it will be ever possible to learn the nature of the structure of the corona. Of their value, even when it comes to prophesying the coronal form, an instance may be taken from the present eclipse. From the coronal photographs of 1898 it was strongly suspected that there was an intimate relationship between the great coronal streamers and the prominences; these lying at the base of the great synclinal curves, and apparently modifying the form and nature of the corona in their immediate neighbourhood. Though this could not be proved to be more than a suspicion it was sufficient for us, when Mr. Evershed telegraphed to us from Pont Mazaframan on the morning of the 28th that there was a large prominence in position angle 226°, to warn Mr. Wesley and those other observers who were intending to draw in detail a small portion of the corona in the telescope, that this region was probably the base of a great ray. The event justified the prophecy, and Mr. Wesley, Mr. Crommelin and Miss Leake have examined with great particularity this part for comparison with the photographs of the base of the great ray.

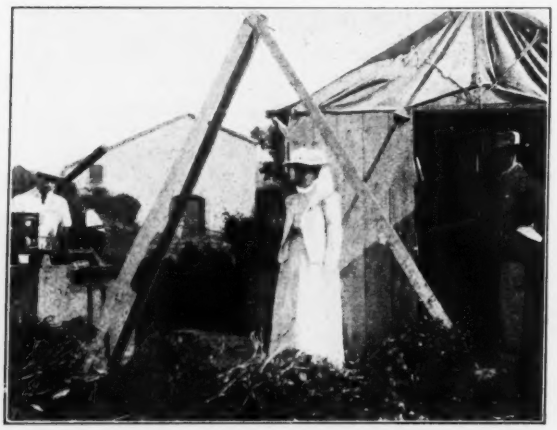
So, too, it will be necessary to continue the observations of the spectrum of the "Flash" and of the corona, both with the slit spectroscope and with the object-glass prism, even though we may not expect them to differ in any important particular from those that have been taken at previous eclipses.

Apart from these regular and routine observations, several strong efforts have been made in the 1900 eclipse to push forward enquiries in various directions into the nature and form of the sun's surroundings.

Of these, the most important are the attempts of Sir Norman Lockyer and of Mr. Evershed, by different methods, to gain a more intimate and detailed knowledge of the spectrum of the "Flash." Sir Norman Lockyer took his station on the central line in the ordinary way, and relied for his success on the use of a longer focal length and consequently a larger image of the sun with his objective prism than has ever yet been employed. He was favoured by very clear skies, and his telegrams have announced the general success of his photographs. How far he has been successful in his special object of finding to a more minute degree the level or levels, above the sun's surface of the gases which give the spectrum of the "Flash," it must of course be many weeks before we can know.

Mr. Evershed conceived a bolder plan, which proved successful in all but one vital point, for which indeed Mr. Evershed cannot in any way be held responsible. Forsaking the central line with its many seconds of totality, he took his station near the edge of the shadow, where as he hoped his total phase would be reduced

to some 20 or 25 seconds. His object was two-fold; to get a rolling or grazing contact of the limbs of the sun and moon whereby the "Flash" would be given out all along the osculating surface; and to get the "Flash" not near the sun's equatorial regions, as do the observers on the central line, but at the sun's pole. Thereby it may be judged whether the constituents of the sun's surroundings vary with their solar latitude.



Mr. Evershed's Observing Hut at Mazafram, showing the Cœlostat.
Photographed by E. WALTER MAUNDER.

In addition he used two large prisms in conjunction with a large reflector. It is already a matter of history how that Mr. Evershed found himself, when the shadow passed, about one hundred yards outside it, and not as he had hoped two miles within. Though actually outside the total phase, he got some photographs of the "Flash" of most exceptional beauty; but probably not one-fourth of the result which he would have got had he had more accurate values for the position of the shadow track.

In another way his experience is of very great value, though not by any means in the manner he intended or desired. The farmers and sightseers in his near neighbourhood had a vehement discussion as to whether the eclipse was total or not. They divided themselves into two parties, those who saw the sun completely disappear, and those who described the corona as creeping round to the moon up to a point where there was a small remnant of sunlight. It got as far as this point but no further, and straightway began to creep back again and vanish. These latter also spoke of the sharp dividing line of light and shadow which sped across the Mediterranean to their left hand. The division was, or appeared to them to be, bordered by a bright line. Investigation proved that both the parties were in the right, for they had been separated by some five hundred yards, the line of total phase passing between the inner party and Mr. Evershed's tent. This unique observation affords a most accurate datum to correct the computation of solar eclipses in the future. It is a pity, however, that such an observation should have been at the expense of Mr. Evershed's special researches.

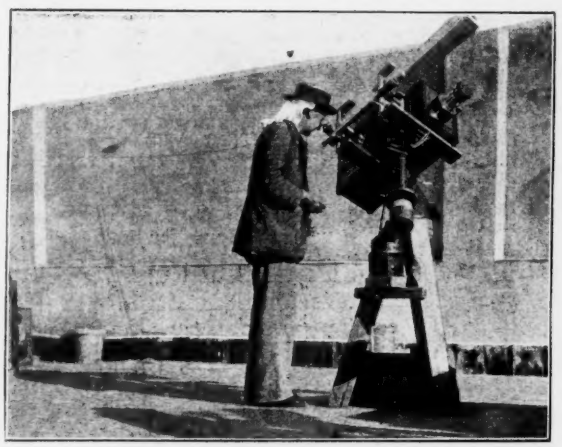
Besides Mr. Evershed at Mazafram, Mr. Newall, Prof. Turner and Mr. Wesley at Bou Zaréa, and a strong party of Swiss and Italian astronomers at Ménerville, more than twenty members of the British Astronomical Association took up their quarters in the city of Algiers itself, and observed with us from the roof of the Hotel de la Régence.

Our own particular work was photographic. It may be remembered that our programme in India was to take *in duplicate* a series of graduated exposures varying in equivalent efficiency from 1 to 1800. Our hope had been that the longer of these exposures might secure the faint coronal extensions, but our purpose was in any case to learn more than had yet been done as to the real efficiency of different exposures in coronal photography. It was the first time, it was the only time, that such an attempt had been made except within quite narrow limits.

It is well known that we were doubly fortunate. Our series included six different exposures equivalent to 1, 4½, 20, 90, 400, 1800, each exposure being given in duplicate so that twelve plates were exposed in all. From the twelve plates we secured four photographs successful as such, but each plate had its full value as a lesson in exposures, and three recorded the long rays.

Seeing that our longest exposures were the most successful in bringing up the long rays, the question before us this time was, Had we reached the limit in India of successful exposure, or had we not? If not, how far could we extend it?

Here we met a serious difficulty, for totality at Algiers would last barely 62 seconds, and we could not



On the Roof of the Hotel de la Régence, Algiers. Rev. C. D. P. Davies and Telephotographic Caméra.
Photographed by MISS EDITH MAUNDER.

expose for the entire time. It was moreover our principle to trust nothing to a single plate; we resolved to adhere strictly to our Indian precedent in this respect and make every exposure in duplicate.

We got over the difficulty in this way. We purchased a second Dallmeyer stigmatic lens of the same aperture and focal length as that used in 1898, and we exposed a plate with each for 48 seconds instead of 20 seconds in India. This was to increase the exposure in the ratio of 12 to 5. We were anxious, however, not to confine ourselves to a pair of exposures of one length only, and consequently purchased a pair of R.R. lenses of focal length double that of the stigmatic, and which we used at the same aperture as we had done the former, namely, 1½ inches. The effective exposure therefore for these lenses—which we also exposed for 48 seconds—was but one-quarter that of the stigmatic or three-fifths the longest exposure

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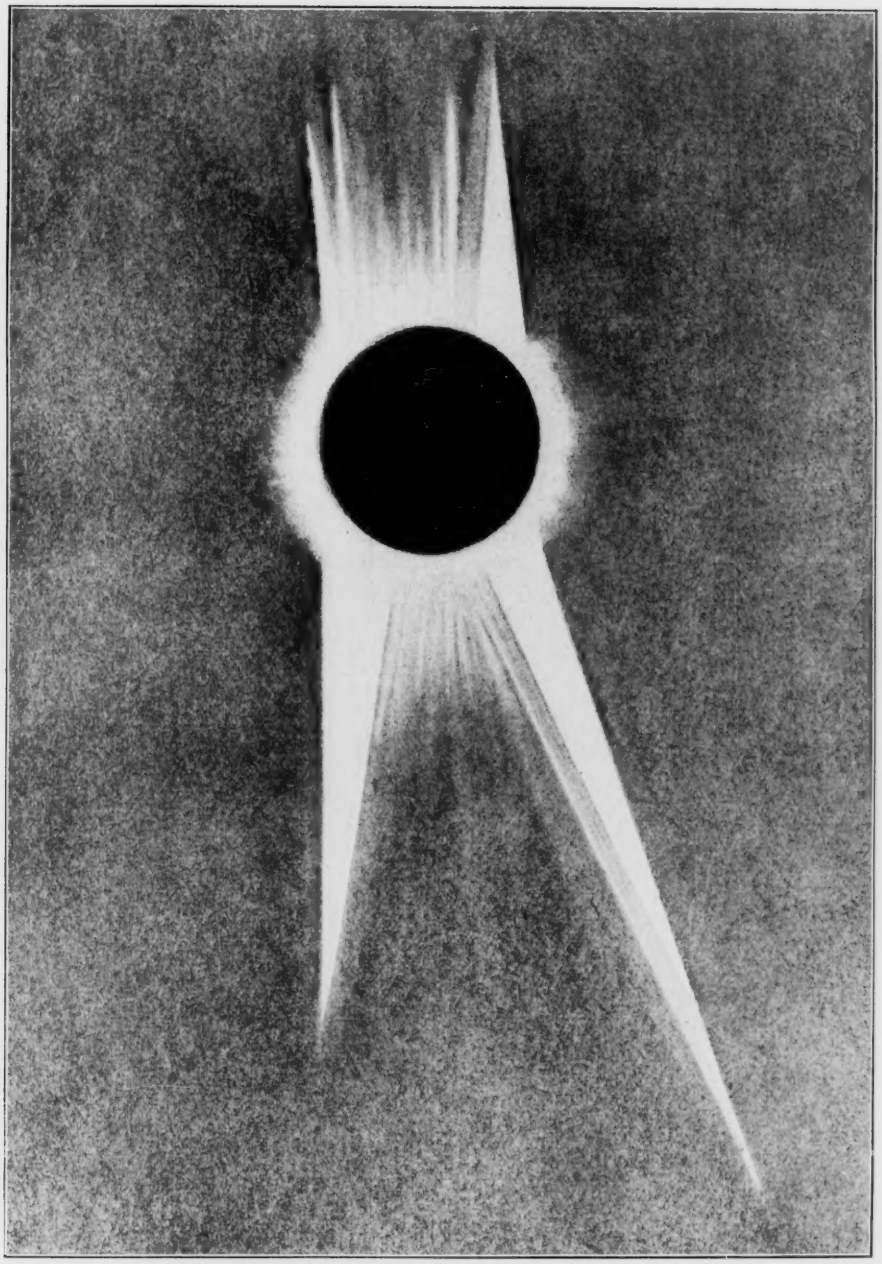


THE CORONA OF 1900, MAY 28.

From a Drawing by Miss Catherine O. Stevens, at the Hotel de la Régence, Algiers.

XUM

given in India. We hoped that the two pairs of exposures would therefore enable us to judge whether our Indian exposures were the best possible, or whether they were too long, or whether, on the other hand, they might be safely increased. For the rest we had no wish to exactly repeat our Indian experiment, as we knew that this was being done by many competent photographers with a variety of lenses and at several widely separated stations.

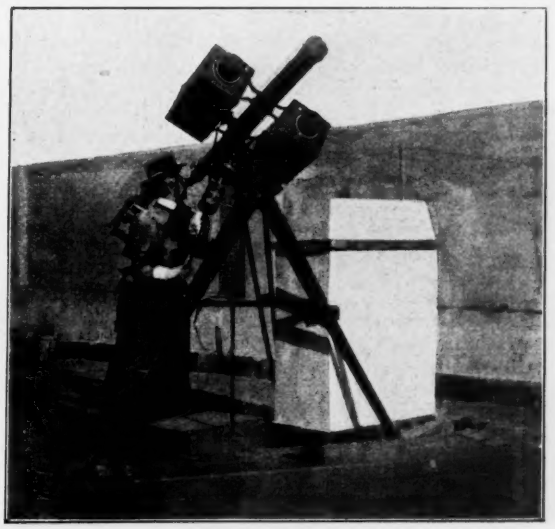
The result of our photographs show clearly that for this eclipse at any rate the exposures which we have given are too long; at least for the purpose of securing the extensions. Totality lasting but for 62 seconds, an exposure from the sixth second to the fifty-fourth meant that the chromosphere was uncovered both at the beginning and end of totality, and that the brightest layers of the corona were practically exerting their influence the whole time. The consequence was that the sky illumination was far greater than at mid-totality in the Indian eclipse, and probably on this account the extensions cannot be traced to so great a distance. We can feel no regret that this is the case. It was our deliberate choice to extend the exposure as much as the circumstances of the eclipse allowed that we might complete our Indian experiences as fully as possible. We trust, however, and have reason to hope that at some of the other stations—possibly at several—those photographers who were trying for the extensions will prove to have secured them to a much greater extent than we have on the present occasion. Nevertheless, our photographs seem sufficient to show that those rod-like rays stretch out from the synclinal curves of the corona of 1900 as they did from that of 1898.

The present article is already sufficiently long, and we

On the Roof of the Hotel de la Régence, Algiers. Miss Leake at her Telescope.
Photographed by MISS EDITH MAUNDER.

must postpone to another month the consideration of many important observations. Amongst these we would specially mention studies at the telescope of the details of coronal structure. These were carried out most successfully on the present occasion by Mr. Wesley, Mr. Crommelin, Miss Leake, and no doubt many others, and form quite a new chapter in coronal observation. The observations of the shadow bands were also of unusual interest, and no doubt the next week or two will bring us much further information as to the details of coronal structure shown on the numerous short exposure photographs.

We reproduce a beautiful drawing made at our



On the Roof of the Hotel de la Régence, Algiers. Mrs. Walter Maunder and her Two Cameras.
Photographed by MISS EDITH MAUNDER.

Algiers station by Miss C. O. Stevens. It will be seen that the form of the corona reproduced with astonishing fidelity that seen in the eclipses of 1878 and 1889, respectively two and one complete sunspot cycles earlier.

THE GREAT INDIAN EARTHQUAKE OF 1897.

By CHARLES DAVISON, SC.D., F.G.S.

To the inhabitants of India, the year 1897 will long rank as a year of great calamities. A famine in Bengal and the plague in Bombay were followed on June 12 by an earthquake in Assam, which, if it is not without a rival, is certainly one of the most disastrous and widely felt of which we possess any record. The investigation of the earthquake was at once undertaken by the members of the Geological Survey of India. The four officers who were at the headquarters in Calcutta were despatched to collect information from the area in which the chief damage was done, letters and circulars were distributed as widely as possible, a large number of volunteer observers were induced to co-operate by keeping records of the after-shocks, and, later on, during the cold weather of 1897-1898, Mr. R. D. Oldham, one of the superintendents of the Survey, made a tour through the epicentral district. To Mr. Oldham has also fallen the much more severe task of collating the observations, of determining the value to be assigned to each, and of discovering the conclusions to which they lead. The latest volume of the *Memoirs* of the Geological Survey of India, a book of more than 400 pages, contains the fruit of his work; the interest and importance of which will be seen from the summary given in the following pages.

DISTURBED AREA, ETC.

The area over which the earthquake was perceptible

is shown in Fig. 1. It will be seen that its boundary (indicated by a dotted line) can only be traced for part of its course; for one-third of the area, Mr. Oldham estimates, lay in regions from which information was unobtainable, while another third is sparsely inhabited by ignorant and illiterate tribes. But, notwithstanding this, the shock is known to have been felt over an area of at least 1,200,000 square miles. If we include the detached region to the west, near Ahmedabad, the portion of the Bay of Bengal in which the shock would have been perceptible if the sea had been replaced by land, and a large part of Thibet or Western China, from which no reports have come but in which the shock was certainly sensible, this estimate, great as it is, must be raised to about 1,750,000 square miles.

It does not appear that any other earthquake, of which we possess reliable records, has been felt over so wide a region. Until 1897, the great Lisbon earthquake of 1755 had no competitor in this respect; but of its disturbed area we have no exact knowledge, for the focus was situated beneath the Atlantic Ocean. There are some doubtful records of the shock having been actually felt at Reading and in Derbyshire, and also at Milan and Turin. If we exclude these, Mr. Oldham estimates the total area over which the Lisbon earthquake would have been felt, had it all been dry land, as not more than a million square miles.

Of the other two curves on the map in Fig. 1, the continuous line represents the epicentral area, and the broken line bounds the district in which serious damage was done to masonry. The area of the latter is not less than 145,000 square miles, or 160,000 square miles, if we include the part from which records were not obtainable.* Calcutta lies within the area of destruction, and a good deal of damage was done to buildings in the city; but this, as Mr. Oldham points out, was largely due to their peculiar mode of construction.

Figures, such as those quoted above, give but little idea of the vastness of the areas concerned. Transferring them to countries with which we are better acquainted, we may say that the disturbed area was only a little less than half the size of Europe; the region in which serious damage occurred to masonry was more than twice as large as the whole of Great Britain; while, if the centre of the epicentral tract had been in Birmingham, nearly every brick and stone building in England and Wales from York to Exeter would have been levelled to the ground.

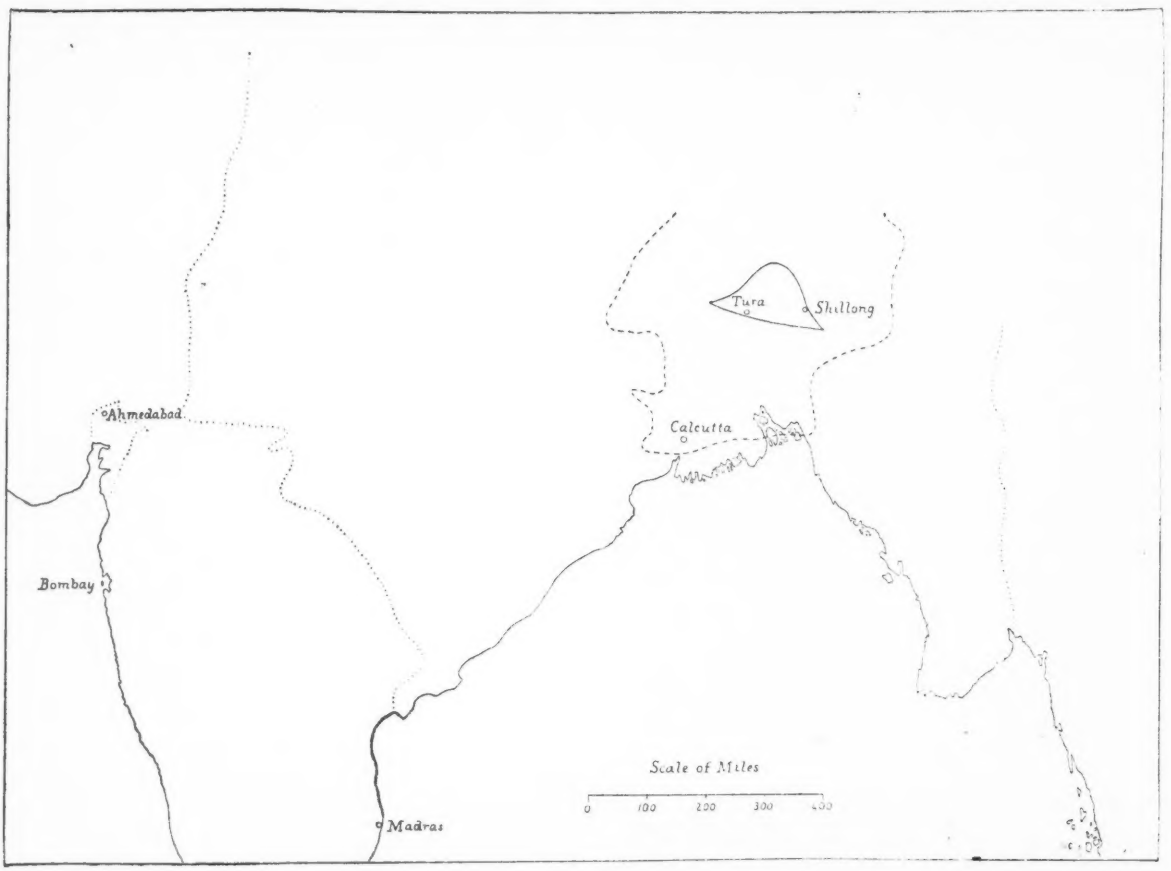


FIG. 1.—Map of the Disturbed Area of the Indian Earthquake of 1897.

* Mr. Oldham does not refer to the corresponding area for the Lisbon earthquake. I am not prepared to make even a rough estimate of its extent; but, if the reports of damage in Spanish towns (without speaking of those in Morocco) are correct, it must, I think, have been in excess of the higher of the above figures.

NATURE OF THE SHOCK.

"I was out for a walk at the time," says Mr. F. H. Smith, of the Geological Survey of India, "and was standing on the road which passes the foot of the filtering tank of the Shillong waterworks, near the school. At 5.15 (according to the ordinary Shillong time) a deep rumbling sound, like near thunder, commenced. The rumbling preceded the shock by about two seconds, and the shock reached its maximum violence almost at once. The ground began to rock violently, and in a few seconds it was impossible to stand upright, and I had to sit down suddenly on the road. The shock was of considerable duration, and maintained roughly the same amount of violence from the beginning to the end. It produced a very distinct sensation of sea-sickness. The earth-movement was exceedingly sudden and violent. The feeling was as if the ground was being violently jerked backwards and forwards very rapidly, every third or fourth jerk being of greater scope than the intermediate ones. The surface of the ground vibrated visibly in every direction, as if it was made of soft jelly; and long cracks appeared at once along the road. The sloping earth-bank round the water tank, which was some 10 feet high, began to shake down, and at one point cracked and opened out bodily. The road is bounded here and there by low banks of earth, about 2 feet high, and these were all shaken down quite flat. The school building, which was in sight, began to shake at the first shock, and large slabs of plaster fell from the walls at once. A few moments afterwards the whole building was lying flat, the walls collapsed, and the corrugated iron roof lying bent and broken on the ground. A pink cloud of plaster and dust was seen hanging over every house in Shillong at the end of the shock."†

Many other observers within and near the epicentral district noticed a marked undulation of the ground. According to one at Shillong, the surface of the earth presented "the aspect of a storm-tossed sea, with this difference that the undulations were infinitely more rapid than any seen at sea." Mr. Oldham thinks that, on an average, the waves were about 30 feet long and one foot in height, though some may have been both shorter and higher. They could be seen following each other at intervals, and the rate at which they travelled, as one witness states, "though decidedly faster than a man could walk, was not so fast as he could run."

In the epicentral area there was a considerable vertical component in the motion, for loose stones on the roads were tossed in the air "like peas on a drum." At the same time there was a still more marked horizontal movement, the range of which must have been at least 8 or 9 inches, and during which people felt as if they were being shaken like a rat by a terrier. As they left the epicentral region, the waves lengthened out, so that, at a distance, the shock no longer consisted of short jerks but became a gentle rocking motion, occasionally giving rise to a sensation of nausea.

SOUND-PHENOMENA.

According to an observer at Shillong, the crash of houses falling within thirty yards was completely drowned by the roar of the earthquake. The sounds are generally described as resembling distant thunder, the passage of a train or cart, etc. There was the usual conflict in the evidence of different observers due to the depth of the sound.‡ In Calcutta, which lies well within the sound-area, some persons asserted that they heard a rumbling noise; others were positive that the only noise was that caused by falling buildings and furniture. Some, again, noticed that the shock was preceded by a loud roar; while others were certain that there was no sound of any kind until the earthquake had become severe.

Leaving possibly doubtful records out of account, the sound was heard for a distance of 330 miles to the west and south-west, and 290 miles to the east of the epicentral area; that is, allowing for the dimensions of that area, it must have been perceptible over a district measuring not less than 800 miles from east to west.

Besides these sounds, several observers in different parts of the disturbed area heard after the shock was over three or more loud and short explosive sounds, like the booms of cannons fired a few miles away. Though, as Mr. Oldham remarks, the sounds were evidently connected with the earthquake, they were separated from it by an interval too great for them to be due to the passage of the sound-wave through the air.

AFTER-SHOCKS.

However scanty the preparation for it may have been, a great earthquake is always followed by an attendant crowd of after-shocks, which, for months or even years, do not altogether cease. Near the centre, they are so numerous as to baffle all inquiry. For several days, it may be, the ground is hardly ever still. At Tura, in the epicentral area of the Indian earthquake, several hundred shocks were at first felt every day, and for three or four days a hanging lamp was kept constantly on the swing; while, at another place within the same area, the surface of a glass of water standing on a table was for a week in a constant state of tremor. On June 13, the day after the great earthquake, there were two shocks which would certainly have caused considerable destruction in the central area if any houses had been left standing; while a third shock, later in the day, was felt as far as Calcutta.

VELOCITY OF THE EARTH-WAVES.

Among the minor problems which a great earthquake presents for solution, one of the most important is to determine the velocity with which the earth-waves were propagated along the surface. The best determinations of the time are those which were obtained from a few self-recording instruments, from the more busy telegraph-offices, from the larger railway stations, and especially from those on the main lines, and in some cases from private individuals. The average of the observations at Calcutta (including that from the tide-gauge) gives 16h. 27m. 49s. (Madras time, which is 5h. 20m. 59.2s. in advance of Greenwich time) for the beginning of the shock. Bombay lies outside the disturbed area, but the initial time there, as determined from the diagrams of three magnetographs and a barograph, is 16h. 35¾m. These two records are probably the most accurate of the series. In calculating the surface-velocity of the earth-waves, Mr. Oldham assumes that they started from a point in lat. 25° 45' N. and long. 90° 15' E. From this point, Calcutta is 255.5 miles distant, and Bombay 1208.3 miles. The average velocity for the intervening distance is therefore 119 miles a minute or 3 km. a

† I have abridged this account slightly, without indicating the passages that are omitted.

‡ See KNOWLEDGE, Vol. XXIII., 1900, pp. 83-85.

second. With this estimate, the other observations are in fairly close agreement.

The Unfelt Earthquake.

Far beyond the limits of the disturbed area, the earthquake was recorded by many of the delicate instruments constructed for the registration of distant shocks.§ All over Italy, from Ischia and Catania in the south to Pavia in the north, these instruments began, one after the other, to write their records of the movement, as the unfelt earth-waves sped outwards from the centre. Italy passed, the tale was taken up by magnetographs at Potsdam and Wilhelmshaven, Pawlovsk (near St. Petersburg), Copenhagen, Utrecht, and Parc St. Maur (near Paris); by horizontal pendulums at Strassburg and Shide (in the Isle of Wight), and by a bifilar pendulum at Edinburgh. Shide is 4891 miles from the centre of disturbance, but the movement could be traced for a distance greater even than this.

In the more complete records, and especially in those given by the Italian microseismographs, Mr. Oldham distinguishes three phases of motion. The first consists of nearly horizontal rapid displacements of the instruments without any undulating movement of the ground. In Italy, it begins at about 11.17 a.m. (G.M.T.), that is, about 12½ minutes after the commencement of the shock at the epicentre. Without any break in the movement, and after the lapse of about 8½ minutes, the second phase begins; the vibrations are similar to the preceding, but they are larger and more open, and are accompanied by an unmistakable tilting of the surface of the ground. Lastly, after the lapse of nearly 20 minutes more, the second phase gives place, without interruption, to the third, consisting of well-marked slow undulations, which have been aptly compared to the movements caused by an ocean-swell. As they travelled over Europe, the surface of the ground was thrown into a series of flat waves, 34 miles in length, and 20 inches in maximum height, the complete period of each wave being 22 seconds. This phase is by far the longest of the three; in the more sensitive instruments, two or three hours elapsed before their traces ceased to show signs of movement.

As we know the distances of the different observatories from the epicentre, and the times taken by each phase to reach them, we can form some idea of the rates at which they travelled. If the early tremors moved in straight lines, their mean velocity for the first phase was 9.0 kilometres per second or about 345 miles a minute, and for the second 5.3 kilometres per second or about 200 miles per minute. But if, as is probable, they moved along curved paths through the body of the earth, their mean velocities must have exceeded these amounts. For the first undulations of the third phase, the velocity would be 2.9 kilometres per second or 109 miles per minute if they travelled along straight lines, or 3.0 kilometres per second or 115 miles per minute if they moved along the surface of the earth.

The existence of the second phase was noticed for the first time by Mr. Oldham in the records of the Indian earthquake, but he has since detected it in those of other shocks.‖ He believes, in common with most other seismologists, that the first phase corresponds to waves of elastic compression travelling through the body of the earth; and he attributes the second to waves of elastic distortion travelling in the same way, in which the particles move at right angles to the direction in which the wave travels, thus causing a slight tilting of the surface. It is probable that the waves of both phases move along curved, rather than straight, lines through the earth, that the curves are concave towards the surface, and that the velocities of the waves increase with the depth of their path below the surface. On the other hand, the surface-velocity of the first undulations of the third phase is practically constant for all distances from the epicentre, and, in the case of the Indian earthquake, it agrees almost exactly with that obtained for the velocity within the disturbed area and as far as Bombay. It is therefore difficult to resist the conclusion that the third phase consists of undulations which travel along the surface of the earth.

If this be the case, we can imagine these undulations speeding outwards from the epicentre in ever-widening circles, until they have passed over a quarter-circumference of the earth, when they should begin to converge towards the antipodes. Here they should cross each other, and again spread out as circular waves, once more in their course passing the same observatories where they were first recorded, but in the opposite order. It has been reserved for the most violent earthquake of modern times to verify this interesting conclusion. Faint, but decided, are the traces of the second crossing. At Edinburgh they occur at 2.6 p.m., and at about the same time at Shide, at Leghorn 2.10, Catania 2.12¾, while at Ischia there are several movements between 2 and 3 p.m. At Rocca di Papa, near Rome, the time is slightly earlier, but the undulations, like those at the first crossing, have a complete period of about 20 seconds. The distances traversed by the waves are more than 20,000, instead of less than 5000, miles; but the mean velocity of travel is almost exactly the same as at first—namely, 2.95 kilometres per second, or 111 miles per minute.

(To be concluded.)

§ For descriptions of the more important see *Brit. Assoc. Rep.*, 1893, pp. 291–308; 1895, pp. 85–86; 1896, pp. 40–49; 1897, pp. 10–11. *Nature*, Vol. L., 1894, pp. 246–249. *Natural Science*, Vol. VIII., 1896, pp. 233–238.

‖ *Phil. Trans.*, 1900, A., pp. 135–174.

AMERICAN INDIANS.

By R. Lydekker.

Although now used in a totally different sense, the title of Americans undoubtedly belongs by right of birth to the aboriginal tribes who were in possession of the New World previous to the incursion of the white man and their modern pure-bred descendants. But to change this usage is now clearly impossible, and some other general title must consequently be sought. By a curious misapplication of terms the American aborigines are almost invariably spoken of as "Indians," while the natives of Hindustan, to whom that name by right belongs, are scarcely ever so called, except indeed by those well-meaning enthusiasts who seek to claim "India for the Indians." Still it is, on the whole, the wisest course to bow to custom and accept the current name of American Indians; the alternative designation of American Aborigines, or the Aborigines of America, being too cumbersome for ordinary use.

There is, it is true, the popular title of "Redskins"; but this, however expressive it may be, is somewhat too "slangy" for present purposes. Moreover, it has been objected to as inappropriate—but of this more anon.

If we except the Eskimo of Arctic America and Greenland, and in a less degree the natives of Tierra del Fuego, the most remarkable fact connected with American Indians, when considered from a zoological standpoint, is that they all belong to the same general type of structure, still in minor details many of the tribes from widely separated areas will be found to differ from one another to a considerable extent. No more striking instance of this fact is to be found than the extraordinary similarity existing between skulls obtained from regions so far apart from one another as Vancouver Island, Peru, and Patagonia—a similarity so great that it is often practically impossible to distinguish between them.

In spite of this adherence to one general physical type, the racial unity of the American Indians has been called in question by several writers; and it has even been suggested that many of the tribes, and especially those of South America, owe their peculiarities to immigration from Japan, China, Polynesia, or elsewhere. But it may be taken for granted that no immigration on a large scale could ever have taken place by sea from either of these areas to America; and if one, or even two or three junks or canoes were from time to time drifted to the shores of the New World it is quite certain that any modifications in the coast population of the latter due to marriage with the shipwrecked crews would be obliterated within a very short period.

We may take it, then, as a fact that the pure-bred American Indians (and it is these alone that concern us), from Canada in the north to Patagonia and Tierra del Fuego in the south, form but a single race. And the question then arises whether the ancestors of that race obtained an entrance into America from the Old World, or whether they were American from the beginning. To that question—provided we are believers in evolution—the answer is very short and simple. On the evolutionary hypothesis man must be descended from the ancestors of the manlike Apes—whether his origin be single or multiple need not concern us here; and since the manlike Apes, both now and in the past, are quite unknown in the New World, it is manifest that the original American Indian must have been an immigrant from the Old World. That such an immigration must have taken place at a very remote epoch is proved by abundant evidence; but the available data are at present quite insufficient for forming even an approximate estimate of the length of time that has elapsed since that distant epoch. With regard to the route by which man reached the New World, the probability that an isthmus formerly occupied the present area of Bering Strait suggests that line of migration. And this view receives a considerable amount of support from the fact that the nearest relatives of the American Indians are the Mongols of north-eastern Asia. Still it has to be admitted that climatic conditions present a certain amount of difficulty in our definite acceptation of that line of route as the one by which the progenitors of the American aborigines reached their western home. Moreover, from the fact that skulls of both an elongated and a short type have been discovered in certain superficial deposits of Argentina and Brazil, some writers have been led to conclude that a double emigration took place into America—namely, a migration of round-headed Mongols from Asia by way of Bering Strait, and another, and perhaps earlier, incursion of long-headed people from Europe by way of Greenland. But if we are right regarding the native Americans as a branch of the Mongol stock, it is difficult to see how they can at the same time be considered to include a large admixture of primitive Caucasian blood; and it must be borne in mind that the Eskimo, who can scarcely be regarded otherwise than modified Mongols, are essentially a long-headed people.

By whatever route, or routes, he reached the Western hemisphere, man having arrived there became at once (or, in the case of two migrations, eventually) entirely separated from his relatives in the Old World. Having been thus isolated during the long ages which elapsed between the period of the original migration (or migrations) and the white colonization of the New World after its reputed discovery by Columbus, the wonder is not that the aboriginal American differs so decidedly from the Mongol, but rather that there are so many points of resemblance still remaining between the two. And here it is important to mention that, in all probability, it is not the American Indian alone whose type has become modified in the course of ages, but that the Mongol has also undergone a certain amount of change since the date when the western and eastern branches of the common ancestral stock parted company for ever.

There are four chief features in which the American Indians conform to the Mongol type—namely, in colour, in the characters of the hair of the scalp, in the very slight development of hair on the face, and in the more or less marked prominence of the cheek-bones. As regards colour, it is well known that all Mongols have a

FIG. 1.—A Typical North American Indian.

yellow skin, and this yellow tinge is frequently retained in their American cousins, although in many instances it is replaced by coppery red. It is true that this red tint is stated by some writers* to be solely due to paint-

* *See* Deniker, "The Races of Man," page 517. (1900.)

ing, and that the American Indian is invariably yellow. But Mr. Im Thurn, who has had special opportunities of observing them, describes the skin of the Indians of British Guiana as cinnamon red; and a bust of a Macusi boy, now in the British Museum, which was modelled and coloured by Mrs. Im Thurn, is of a bright clarety-red. As these Macusi Indians are noted for their frequent ablutions, it is evident that they exhibit the natural hue of the skin; and it may accordingly be taken as a fact that a reddish skin is characteristic of at least some of the aboriginal tribes of America.

Although there are stated to be certain South American tribes in which it displays a tendency to waviness, the scalp-hair of the typical American Indian is of the long, coarse, straight, black type which forms such a characteristic feature of the Chinaman. Hair of this type presents a perfectly circular cross-section, and therefore has no tendency to twist, but hangs as straight down as that of a horse's mane or tail. It is to be met with from Canada to Patagonia, all North American Indians exhibiting this type in perfection (Fig. 1); while it is equally apparent in those curious mummified and shrunken heads from Ecuador which command such high prices at "curio" sales. In the above instances the hair is allowed to grow long, when its characteristic features are best displayed; but in many tribes of South America, such as the Tupis of Brazil (Fig. 2), it is cut short, when a more European appearance is given to the entire countenance. In both the figures just referred to, the absence of hair on the face, which forms such a marked characteristic of both Mongols and American Indians, is very conspicuous; but it should be added that, like Chinamen, the majority of the native tribes of America are in the habit of plucking out the comparatively few hairs that make their appearance on the face. As regards the cheek-bones, these are always decidedly more prominent than in Europeans, although less projecting than in Chinese. Generally speaking, the degree of prominence is considerably more marked in the tribes of North America than in those further to the south, as may be seen by comparing Fig. 1 with Fig. 2; and, indeed, this is just what might be expected to occur on the hypothesis that the American aborigines came by land from Asia, since the further south they wandered the more widely they would tend to depart in physical features from the Mongolian prototype. But in spite of this and other differences to be noticed immediately, the retention of the Mongoloid type even among the natives of South America is very noticeable; Sir William Flower remarking that no one can have seen a group of Botocudos from Brazil or of natives of Tierra del Fuego without being struck by their markedly Mongolian external features.

Turning to the points in which American Indians differ from their Mongolian cousins, the most important are to be found in the retreating slope of the forehead, the development of distinct brow-ridges above the eyes, the general absence of obliquity in the eyes themselves, and the much more prominent nose, which is usually narrow, with a high bridge, and frequently an aquiline profile, in which two lines meet at an obtuse angle at the bridge. All these points of difference tend to more or less completely obliterate the breadth and flatness of face so characteristic of the oblique-eyed Mongol. But here and there cases are recorded where, instead of the small, sunken, and circular coal-black eye, the eyelids assume the typical Mongolian folding and obliquity, and thus communicate a strikingly Chinese expression to the entire countenance. In this connection it has to be borne in mind that the Malays, who are comparatively near relatives of the Chinese, have more or less completely lost the oblique and slit-like "Mongol eye," so that the disappearance of the same feature in the American tribes should be no cause for wonderment. It might, of course, be urged that the "Mongol eye" was acquired in Asia subsequently to the splitting-off of the American branch, but the fact that the feature

Fig. 2.—Male Indians of the Turi-nara Tribe of the Tupi Stock, from the Rio Ncara, Para, Brazil.
Photographed by Dr. E. Goeldi.

in question occurs to a certain extent among the Eskimo, an ancient Mongolian offshoot whose relationship to the American Indians is not yet decided, seems to be decidedly against such an hypothesis.

Another point in which the American Indian differs from his Mongolian prototype is his superior bodily stature; an average height of 5 feet 8 or 9 inches being common over the greater part of the continent, while in Patagonia it rises to as much as six feet. Here, again, we have another instance of the extreme degree of divergence from the Mongolian type occurring in the part of the New World the most remote from Bering Strait. In the Fuegians it is true that the height falls so low as five feet, but this inferiority of stature is obviously due to the hard conditions under which these degraded people exist. Compared with the squat and flat-faced Tatar or Chinaman, the American Indian, in the higher phases of his development, makes indeed a far nearer approximation to the ideal standard of physical beauty, although his features are frequently by no means of a pleasing type, and the practice so common in the northern half of the continent of wearing the hair long, coupled with the absence of beard and moustache, gives the men a somewhat feminine appearance.

Bearing in mind what has been said in regard to the universal prevalence of a long-headed type among the Eskimo, the fact that while the Mongols are a short-headed people, a large proportion of the American aborigines have heads of medium length, can scarcely be regarded as a distinctive feature of first-class importance.

It is, moreover, noteworthy that the Indians of North America may be divided into an eastern, or Atlantic, and a western, or Pacific, section, the former of which is characterised by its tall stature and moderately long head, while the latter is of inferior bodily height and shorter-headed. In this instance also we see the section nearest to Bering Strait retaining the Mongoloid characters, although it should be added that they are somewhat more hairy than the eastern section. For the rest, it must suffice to say that both long, medium, and rather short-headed tribes are met with in South America; the former showing a tendency to wavy hair. The tribes in which the head is longest are the Botocudos of

FIG. 3.—Young Females, Turi-nara Indians.
From a Photograph by DR. E. GOELDI.

Brazil, next to whom come the Fuegians, while the approximation to a round-headed type is most marked among the Patagonians.

Apart from the Eskimo, the aborigines of the New World may be conveniently divided into North, Central, and South Americans, and Patagonians. As already mentioned, the North Americans may be divided into a western and an eastern section, the latter being further subdivisible into an Atlantic and an Arctic group. To give the names of the numerous tribes constituting these sections and groups would but weary the reader to no purpose, and would likewise be well nigh impossible within the limits of my space. Allusion may, however, be made to some of the chief linguistic families, or stocks, into which the tribes may be grouped—language being almost the only practical means of classifying American Indians. Foremost among the families of the Arctic slope are the Athabascans: some tribes of which—the Navajos and the Apaches—have, however, migrated south into Arizona and New Mexico. On the Atlantic slope the Algonquians even exceed the Athabascans in numbers, and are the largest living family; some of their best known tribes are the Crees, the Mohicans, and the Chippewas. Among the other Atlantic stocks are the Iroquoians (as represented by the Iroquois and the Mohawks), the Muskhogeans (including the Choctaws, and Creeks or Muskhogis), and the Siouans, some of the most famous tribes of the latter being the Sioux or Dakotas, and the Crows. The Pawnee and Kiowa tribes seem to fall into neither of the great linguistic divisions. Turning to the Indians of the Pacific slope, whose tendency to a round-headed character has been already mentioned, these appear to form but a single linguistic stock. Their most interesting representatives are, however, the so-called Pueblo (Village) Indians of the plateau of Arizona, New Mexico, and parts of the adjacent territories, who have forsaken the nomad habits of their fellow aborigines to dwell in large caves hollowed out of the steep banks of cañons, or in large villages (pueblos) built by themselves. These Mokis and Hopis, as they term themselves, are the tallest and most round-headed of all the North American tribes, and possess a number of very remarkable cults and ceremonies, among which the snake-dance is perhaps the most widely celebrated.

Mexico is largely populated by the Sonoran and the celebrated Aztec group; the former being allied by blood to the North Americans of the Atlantic slope, while the latter are more nearly akin to the tribes of Central America. In their mode of life and customs both approximate to the Pueblo Indians; the Pina and Papajo tribes of the Sonorans, for instance, dwelling in large many-storied dwellings commonly known as *casas grandes*, and cultivating with perseverance the sterile soil of the Gila valley—the home, by the way, of that poisonous lizard which is hence known as the Gila monster (*Heloderma suspectum*). The Aztecs, who populated the Pacific slope at the same time that the Atlantic sea-board was occupied by their relatives the Nahuas, are known to fame by reason of the comparatively civilized empire they had succeeded in establishing a few centuries previous to the devastating advent of the Spanish *conquistadores*. Among the inhabitants of Central America, which also extend into southern Mexico, the most celebrated are the ancient Mayas of the Mayo valley, Yucatan, whose civilization was akin to that of Mexico, while their writing ("the Maya script") forms an anologue to the hieroglyphics of ancient Egypt. Another well-known Mexican tribe are the Miztecs.

Between Guatemala and Panama dwell a certain number of tribes speaking dialects differing from any of the American stock languages; the most noteworthy among them being the Mosco, or Mosquito Indians, who are nearly as black as Negroes, but otherwise conforming to the general American type.

Very brief must be the mention of the South American aborigines, among which are included all those dwelling to the south of the northern frontier of Costa Rica. Among the Andean section the most interesting linguistic stock is that of the Quechua, on account of its including the ancient Incas of Peru. In western South America, Quechua was, indeed, the *lingua franca*, as it is to a considerable extent at the present day; while the Quechua words *condor*, *guano*, *pampa*, and *quina* have been adopted in European languages. While speaking a different tongue, the Araucans, of Chili and part of Argentina, conform physically to the Quechuas and their relatives the Aymaras. In the Amazonian section come the Caribeans, ethnologically distinguished by their use of the hammock, and including a host of tribes, among whom are the true Caribs of the Antilles and many districts of the mainland, and the Makusis of British Guiana; a peculiar feature of the latter being their habit of going about with down-cast eyes. Another linguistic stock in this section is that of the

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Arawaks. The Indians of East Brazil and Central South America form a third section; among whom the Tupi-Guarani linguistic stock, whose language forms the *lingua franca* of the eastern side of the continent, is the most important. To this stock belongs the tribe from Para, of which representatives are shown in Figs. 2 and 3. Lastly, we have the Pampean and Fuegian section. Of the mainland tribes of this section the more notable are the Tehuelches, or Patagonians, who inhabit the country lying between the Rio Negro and the Magellan Strait, and are the tallest of the American aborigines, although somewhat exaggerated notions have been entertained in regard to their height. As to the Fuegians, who are restricted to the southern and western coasts of the bleak island from which they take their name, space only permits of the statement that they are, on the whole, the most degraded and the most wretched of all the American Indians.

SOME EARLY THEORIES ON FERMENTATION.—I.

By W. STANLEY SMITH, PH.D.

IN the year of grace, 1636, Thomas Hobbes, the famous author of "Leviathan," wrote a letter from Paris to the Duke of Newcastle. There are some sentiments in this letter so expressive of the attitudes adopted by the leading natural philosophers of each age, that we may well use them as a prelude to our short survey of the theories that have successively surrounded the fermentation of sugars and other materials. "In thinges," says Hobbes, "that are not demonstrable, of which kind is the greatest part of naturall philosophy, as dependinge upon the motion of bodies so subtile as they are invisible, such as are ayre and spirits, the most that can be atteyned unto is to have such opinions as no certayne experience can confute, and from which can be deduced, by lawfull argumentation, no absurdity." It has been said that the essence of our modern superiority to the earlier philosopher consists in our having accumulated more facts, but a moment's thought will teach us, if, indeed, the lives and works of men like Huxley and Pasteur do not teach us, that our greatest strength lies not so much in mere knowledge of facts, but rather in the acquisition of rightful methods of research, and the clearing of pathways that lead to Nature's most umbrageous nooks and crannies.

Records of fermented juices, both of cereals and fruits, extend as far as historical research can penetrate. Every mention of the results of fermentative changes preceding the era of Christendom is distinguished by the fact that supernatural powers are credited with the functions we now attribute to living realities of daily life, so that Osiris and Bacchus are held responsible for the early wine and beer, and we may deem their adorers justified in their worship, for they had "no certayne experience" to refute the notions they held as to these deities and their functions. The first name of any note is that of the famous naturalist, Pliny, in whose observation of the presence of an acid in the fermentation of bread we discern the primitive glimmerings of investigation in these dark regions; and he possesses a further interest for us, inasmuch as Pliny was probably one of the first martyrs in the cause of knowledge. He died, at the age of fifty-six, whilst attempting to ascend Vesuvius during the historic eruption which laid Pompeii and Herculaneum in dust and ashes. Plutarch, who was born in the year 48, in his works presents us with many curious and trite observations on the learning and customs of those times, and we mention, as especially interesting to our subject, his remarks on the benefit of warmth, and retarding influence of cold, on the progress of fermentation.

It is to Djafer al Geber that we owe the discovery of the art of distillation, besides which he appears to have been the first alchemist to perform the operations of filtering, evaporating, crystallising, and dissolving metals in acids. Geber describes his processes in the mystic phraseology of those times, and does not fail to mention the "elevation of dry substances by fire," now known as the act of sublimation. Rhazes, a Baghdad physician, who flourished between the years 860—940, was the first to give accurate directions for the production of aqua vitæ by distillation, and means by which a still more concentrated spirit may be obtained therefrom—namely, by another distillation over quicklime.

The words fermentatio and digestio appear to have been used by the early alchemists to indicate the same process, namely, a frothing or evolution of gas accompanying a chemical reaction. The substance or reagent causing this evolution of "spirit" was designated the ferment, whilst under putrefactio we are to recognise the gradual decomposition of inorganic substances. It should be remembered that the various products due to vital activity were, until as late as 1828, considered outside the pale of experimental science. In that year Wohler synthesised urea, and thus broke down the barrier that had resisted the attacks of many ages. The hazy ideas anent the differences between what we now, for the sake of convenience, call organic and inorganic chemistry, are well illustrated in writings and sayings attributed to the leading thinkers of the dark ages. Basilus Valentinus, in writing the results of his experiments on fermentation, declares that alcohol is always originally present in the fluid, from which it is subsequently obtained, but that it is only by a process of purification, or as we should now say, fermentation, that the alcohol is freed from other substances, and is thus able to exhibit its characteristic properties. He compared the process to combustion, and plainly tells us his researches were directed towards the discovery of an universal ferment, in fact the lapis philosophorum of which so much was expected.

Libavius, a dim and obscure individual, looms forth from the year 1580, or thereabouts, with an idea which one, Stahl, evidently pondered deeply over. He remarks that somehow or other the substance undergoing fermentation must have an affinity with the cause of its decomposition, or as this cause was named, the ferment. Libavius possessed none of the data accumulated by modern science, anent enzymes and zymes, but can we not here discern the germ of one of the latest theories of fermentation, that proclaimed by Emil Fischer of Berlin, and known to science as the Schloss und Schlussel (Lock and Key) theory?

Turning now to the pages of Hoefer, Lavoisier, or Kopp, we find an account of a great man, Van Helmont, who, born at Brussels in 1577, followed the vocation of journeyman physician, and beguiled his leisure hours with much experiment and writing. The knowledge possessed by Van Helmont of various gases was probably far in advance of that held by his contemporaries, but, like the earlier alchemists, he was but a poor master of descriptive art. However, it is to him we owe the word "gas," borrowed or derived from the

German term "geist," signifying "spirit." Van Helmont tells us of his "gas sylvestre," observed rising from beer and fermenting liquids of various kinds, and was the first to clearly distinguish between this gas (carbon dioxide) and the alcohol remaining in solution. To him we owe the dictum, fermentum volatiliset, quod alias in carbonem mutatur, and in his "Opera omnia," published in 1707, together with, as Huxley remarked, a very needful "Clavis ad obscuriorum sensum referendum," may be found much of interest concerning the learning of his times. Alcohol meant not only spirits of wine, but various other things as well, a fact we may convey by quoting Nathan Bailey's definition. "Alcohol," says this early lexicographer, "is the pure substance of anything separated from the mere gross, a very fine and impalpable powder, or a very pure, well-rectified spirit." Van Helmont was fain to attribute to ferment vitality the origin of all animals, whilst the late Julius von Sachs records in his "History of Botany" the belief of Dedu, who, in 1685, evolved similar ideas regarding the vegetable world. We must not pass over the learned distinction of Silvius de la Boe who threw much light on the knowledge of the sixteenth century, by distinguishing between the nature of gas evolved during fermentation and the evolution discerned when acids are added to alkalies. The first he regarded as incidental to the process of decomposition, whilst the latter attended the formation of a definite chemical compound.

Johann Joachim Becher made the discovery that only sweet substances are fermentable, and that, contrary to the theory of Basilus Valentinus, the alcohol produced was a new substance, arising from the act of fermentation. He makes, also, many sagacious discriminations between putrid decompositions and alcoholic fermentation, but was never quite able to shake off the influence exerted by the fascinations of alchemy. Ernst Stahl, however, whose thoughts lie recorded in a curious old German work, published in 1734, may be defined as a chemist, in contradistinction to a follower of alchemy and its wild alluring dreams. "A body," says Stahl, in the work alluded to, "which is undergoing decomposition is able, when brought into contact with another body not yet decomposing, to excite in this new body a similar process of breaking up; or the vibrations which are going on in the first body are able to communicate themselves to a second body of like nature, which was previously in a quiescent condition." In these words it is easy to discern the germ-thoughts destined to be afterwards enlarged upon by Justus von Liebig, and in some measure by that acute mathematician J. von Naegeli. And, further, Stahl set in motion a branch of knowledge nowadays much advanced, to wit, that concerning the spread of diseases by contagion and infection.

The study of organic structures and materials from a chemical standpoint dates from the year 1701, when Hermann Boerhaave was appointed Lecturer in Medicine, and, later, Professor of Chemistry and Botany, at the University of Leyden. Geber, as we have seen, devoted his life to researches among the inorganic materials around him, and had, doubtless, distilled, sublimed, and precipitated every suspicious-looking mineral or fluid that crossed his path, and now Boerhaave, nearly seven centuries afterwards, proceeds to distil, sublime, and collect from organic sources. This great master directed his attention, like all other great men of science, to the mysteries of fermentation and putrefaction, arriving at the conclusion that only substances of vegetable origin undergo fermentation, whilst animal matters suffer putrid decomposition.

The chemical knowledge surrounding fermentation takes its starting point from the year 1774, when Priestley and Scheele, independently, discovered oxygen. By consulting Priestley's autobiography, we learn how his great discoveries were inspired by a visit to a brewery, which happened to be situated in close proximity to his residence. His curiosity was aroused by observing the bubbles of gas that ascended through the beer during the process of fermentation. This gas was carbonic acid, and with it Priestley manufactured the first bottle of so-called soda-water.

Lavoisier first studied fermentation from a rational point of view. This great chemist observed how, during the progress of fermentation, sugar was decomposed, and he regarded this decomposition as the breaking up of a complicated oxide, to wit, sugar, into substances containing less oxygen. These substances, formed in normal fermentations, were deemed by Lavoisier to be alcohol, carbonic acid gas, and acetic acid, and if we turn over the pages of his "Elements de Chemie," which work was translated by Robert Kerr in 1790, we shall find various quantitative analyses, worked out by the reformer. They do not, of course, bear well the search-light of modern criticism, but in later years, Gay-Lussac and others arose to set such matters aright, and to give us accurate empirical formulæ for both alcohol and sugar.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

IS THE STELLAR UNIVERSE FINITE?

TO THE EDITORS OF KNOWLEDGE.

SIRS,—With regard to the correspondence on the above subject which has recently appeared in your columns, I would beg to point out that there appears to be some misapprehension in the minds of your correspondents regarding the relation of the "Galaxy" to *the whole visible stellar universe*. The general opinion, I believe, is that the Galaxy (to which our sun belongs) is merely *one* amongst many huge star-groups, which, owing to their very great distance, and to the fact that we are *outside* of them, appear to us as star-clusters, and sometimes possibly as nebulæ. If it is intended to confine the discussion to the "Galaxy" alone, then I may say that its general shape, and our position in it—but not, so far as I am aware of, its mean depth or dimensions—are fairly well understood. If the *whole* of the visible stellar universe is to be included, then the question wears a different aspect entirely, and becomes more formidable than I should care to deal with.

ARTHUR ED. MITCHELL.

A LARGE METEOR.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I hope other of your readers besides myself observed a large meteor which was visible here at 8.10 p.m. on the 5th inst. When I had my attention called to it, it appeared to be moving rather slowly east to south, about parallel to the earth's surface, and it disappeared with a pale green flash of light, leaving a dull red spark. It was quite day-light as well as moon-light at the time. W. EARP.

Leicester, May 12th, 1900.

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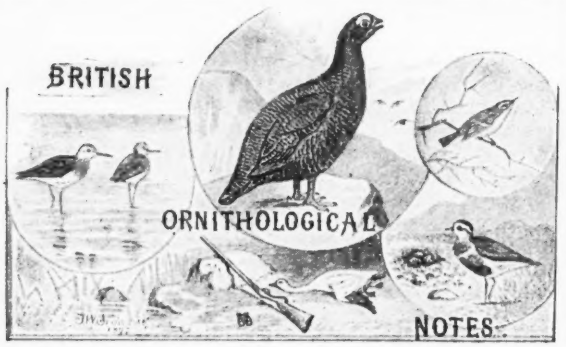

Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

Ducks assuming Drake's Plumage.—On a pond at the Red House, near here, there are two semi-wild ducks (*A. boschas*) in complete drake's plumage. Colonel Taylor, their owner, who bred them himself, tells me they are six years old, but only assumed their present dress two years ago, and like the real drakes, partly lose their male attire in the autumn. I have known hen pheasants assume a good imitation of the cock's plumage, but these two ducks have adopted a perfect drake's dress.—Jos. F. Green, Benacre Hall, Wrentham.

Fowl and Rabbit.—In October, 1899, a keeper here saw one of his hens attacked by a rabbit. The hen in its fright got jammed between some wire netting and a tree, so could not move. Before the keeper could come to the rescue the rabbit had plucked most of the feathers from the bird's back. The idea is that it was a doe rabbit who wanted to line her nest with feathers.—Jos. F. Green, Benacre Hall, Wrentham.

Summer Migrants.—I did not see a swallow this year till Easter Sunday, April 15th; this I consider late, but was probably caused by the long continuance of cold weather. On Easter Monday I saw quite a strong flight of swallows, some sand martins being with them. On the 19th the cuckoo was heard here, and on the 21st I heard the wryneck (the cuckoo's mate). An informant tells me he heard the nightingale about a week before this date. On the 25th I heard the sedge warbler, and on the 28th I saw the first swift and the first house martin.—E. Sillence, Romsey, May, 2, 1900.

Report on the Movements and Occurrence of Birds in Scotland during 1899. By T. G. Laidlaw, M.B.O.U. (*Annals of Scottish Nat. Hist.*, April, 1900, pp. 70-87). This is a very useful report compiled from the notes of a number of observers in various parts of Scotland. The author regrets a slight decrease in the number of observers, as well as in the extent of their observations, as compared to the returns for 1898.

Chiff-Chaff in Barra (*Annals of Scottish Nat. Hist.*, April, 1900, p. 121.) Mr. W. L. Macgillivray records that two specimens of *Phylloscopus rufus* were shot on Barra on November 18th and 20th, 1899. The Chiff-Chaff has hitherto been but doubtfully recorded for the Outer Hebrides.

Long-eared Owl in Barra (*Annals of Scottish Nat. Hist.*, April, 1900, p. 121). Mr. W. L. Macgillivray reports the occurrence of a bird of this species on Barra, on October 28th, 1899. This bird has been recorded but very rarely from the Outer Hebrides.

The Cuckoo: A Study. By Rev. E. A. Woodruffe-Peacock, L.Th., F.L.S., F.G.S. (*The Naturalist*, April, 1900, pp. 99–108.) This is an interesting essay on the habits and notes of the Common Cuckoo.

Ornithological Notes from Norfolk for 1899. By J. H. Gurney, F.Z.S. (*Zoologist*, March, 1900, pp. 97–115.) This forms a record of bird movements and occurrences in Norfolk—an exceedingly useful annual contribution to the pages of our contemporary.

The Hawfinch as a Durham Bird. By J. W. Fawcett. (*The Naturalist*, April, 1900, pp. 113 and 114.) Mr. Fawcett gives a brief history of the occurrence of the Hawfinch in the County of Durham, where it is decidedly increasing in numbers as it is in other parts of England.

Water Pipit (*Anthus spipoletta*) *in Sussex* (*Zoologist*, June, 1900, p. 278). Mr. N. F. Ticehurst records that a female specimen of this rare visitor to England was shot by a boy on February 19th near St. Leonards.

Bird Notes from North-east Lincolnshire during the Autumn Migration of 1899. By G. H. Caton Haigh. (*Zoologist*, May, 1900, pp. 201–212.) The autumn of 1899 was not a remarkable one either for great "rushes" of migrating birds or for any great rarities. Mr. Haigh gives a concise account of the movements of the birds in Lincolnshire.

Natural History Notes from Yorkshire for 1899. By Oxley Grabham, M.A., M.B.O.U. (*Zoologist*, May, 1900, pp. 229–236). These notes are chiefly concerning birds.

Breeding of the Shoveler (*Spatula clypeata*) *and of the Garganey* (*Querquedula circia*) *in Kent* (*Zoologist*, June, 1900, p. 279). It is very satisfactory to learn from Mr. N. F. Ticehurst that both of these ducks have bred in Romney Marsh this year. Both the birds are rare breeders in England, the Shoveler especially so. But both birds are no doubt increasing as a breeding species, and it is to be hoped that with a little more protection from owners of the land they may be induced to appear regularly where they now only visit occasionally.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at 1, Eliot Place, Blackheath, Kent.*

Notices of Books.

"Horns of Honour, and other Studies in the Bye-ways of Archæology." By Frederick Thomas Elworthy. xii. and 315 pp. (John Murray.) 10s. 6d. net. Judged by the canon of pedagogics, which one naturally associates with the name of Herbert, that good teaching must maintain the interest of the pupil in the subject under consideration, Mr. Elworthy's book must be given high praise, for, even throughout the discussion of subjects where many would consider it impossible to develop interest, he always succeeds in retaining the reader's attention. The accounts of the evolution both of "horns of honour" and "horns of the devil," with their plenitude of anecdote and their liberal accompaniment of illustration, abound with evidence of the author's industry in research and of his power with the pen. What we now call crests were, in the Middle Ages, worn as ensigns of high distinction, especially in personal prowess, and few were they who attained unto them; but, says Mr. Elworthy, they have now sunk to be mere fantastic ornaments of the vulgar and the nouveau riche. Starting probably with the idea of the cock's comb, man has, at different times, invented and elaborated wonderful forms of head-dress, which are in the volume before us described in detail. The crests which can be traced back to the shape of the crescent moon seem to be legion but this is not the place to attempt an enumeration; the interested reader must be referred to the book under notice, where he will find them described—down to the widely divergent form seen in the crown of Kaiser Wilhelm. The modern representative of the crescent, not used as a cranial ornament, but for occult reasons of different kinds, is the horse-shoe, which so many use to bring good luck. Sometimes the horn of honour has been turned to base purposes, as Shakespeare knew, for Jaques' song in "As You Like It" runs—

> "What shall he have that killed the deer?
> His leather skin, and horns to wear.
> Take thou no scorn to wear the horn;
> It was a crest ere thou were born.
> Thy father's father wore it,
> And thy father bore it."

The section on "Horns of the Devil," with its biography of this interesting personage, provides a number of quaint tit-bits. There is evidence, we find, that popular imagination made the devil black as early as the death of William Rufus. Church bells were originally intended to keep the devil from church, and the cock was placed on the highest point for the same purpose, whilst the presence of gargoyles is to be similarly explained. The latter half of the volume is concerned chiefly with the hand, or as Aristotle called it the "tool of tools," and the various ways in which the hands have been used symbolically provide plenty of material for demonstrating the extent of Mr. Elworthy's work in collecting and recording data in a somewhat obscure subject.

"Modern Italy, 1748—1898." By Pietro Orsi. xxiii. and 404 pp. (T. Fisher Unwin.) 5s. This latest addition to the deservedly popular "Story of the Nations" series, is from the pen of the distinguished Professor of History in the R. Liceo Foscarini Venice. The translation of the work has been done by Mary Alice Vialls with sympathy and judgment, the result being that the English reader can now study without trouble the history of the

lives and work of the pioneers of modern Italy, and become familiar with such commanding personalities as those of Charles Albert of Carignan, Camille Cavour, and many others, of whom the average Englishman knows next to nothing. It is a little strange that while so many of our countrymen are conversant with Italian art and scenery, and know a great deal about the classic remains which command the attention of every scholar, so little interest has hitherto been developed in the constitutional changes and political controversies that have taken so great a part in Italian life during the last hundred and fifty years. It is hoped the volume before us will do something towards remedying this lack of knowledge.

"Evolution by Atrophy." By Demoor, Massart, and Vandervelde; translated by Mrs. Chalmers Mitchell. (Kegan Paul.) 5s. Much has already been written on the many aspects of evolution, and as science in all its branches throws off new shoots as it were, new territory is constantly being appropriated by the evolutionist in his ever-widening scheme of co-ordination. Bio-sociological science is in unstable equilibrium. The naturalist with his limited knowledge of social questions too often erects leaning towers with the centre of gravity outside the base, and the sociologist, frequently a theorist with little or no training in biology, sometimes builds his pyramids with the apex downwards. This book, by several authors, aims at presenting a well-proportioned view of the structure raised by evolutionists who have prosecuted their investigations into every phase of life and the institutions evolved by civilised communities. It is a work full of interest from first to last, but only a skeleton on which new material may be laid and moulded into shape by competent hands. Great inequality obtains in the several chapters; for example, that on the "Transformation of Organs of Animals" is fairly full, while the section on "Atrophy of Institutions" is somewhat meagre. Nevertheless, it is a work of importance, very suitable for the library.

"Sexual Dimorphism in the Animal Kingdom." By J. T. Cunningham, M.A. xi. and 317 pp. (A. & C. Black.) 12s. net. The phenomena of structure in the animal kingdom may be included, says Mr. Cunningham, under three categories: diversity, polymorphism, and metamorphosis. The present work is devoted especially to the consideration of the commonest case of the second of these divisions, and the arguments presented are chiefly concerned with two special peculiarities of secondary sexual characters, viz.. (1) these characters do not begin to appear in the individual until it is nearly adult and sexually mature; (2) they are inherited only by the sex which possesses them. Mr. Cunningham maintains that heredity causes the development of acquired characters for the most part only in that period of life and in that class of individuals in which they were originally acquired. In other words, heredity is a tendency in the new individual to pass successively through the same stages of growth as its parent. The theory of evolution put forward, which the author claims as new and original, is stated as follows: "that the direct effects of regularly recurrent stimulations are sooner or later developed by heredity, but only in association with the physiological conditions under which they were originally produced." In opposition to Weismann, the question of how the inheritance of acquired characters can be produced is not discussed; in the author's words, "it is a fact that the modifications with which I have to deal are hereditary, and my object is to produce inductive evidence that they were determined by special stimulations." After defining his position and setting forth the explanation he has to offer, Mr. Cunningham reviews the facts which have been observed in the chief divisions of the animal kingdom, the successive chapters being concerned with Mammals, Birds, Reptiles and Amphibia, Fishes, Insects, and lower sub-kingdoms. It is hardly our province to refer in detail to so highly specialised a piece of work as that contained in this volume. Moreover, there is, after all, only a comparatively small amount of material yet available on which to build theories, and it may well happen that the accumulation of further data will lead to a necessity for a restatement of the case—a contingency fully recognised by the author. However this may turn out, Mr. Cunningham's work is one that claims, and will doubtless receive, the serious consideration of biologists.

"The Structure of the Brain." By Albert Wilson, M.D. (Elliot Stock.) Illustrated. "This work is a re-issue of a more expensive book entitled 'The Brain Machine' issued some time since." The dominant note in our author's theme is that we are only machines, the victims of fate, yet so complex that there remains much at present unknown. "It is no use fighting a fractious, self-willed child. Its brain-cells want cleaning and repairing." "After meals we are sleepy, because the blood has left the brain for the abdomen." "Our optic centres absorb it (experience) as a photograph, which we recall every time we are exposed to that small danger." In this manner Dr. Wilson deals with all the ordinary phases of human life, and he is often very happy in his concise mode of expression. The book is exceedingly interesting, and is sustained throughout by exact scientific knowledge.

"A Treatise on Crystallography." By W. J. Lewis, M.A. (Univ. Press, Cambridge.) Crystallography, at the best, is not an attractive study except to those who are well equipped with the elements of geometry and trigonometry, and who have, moreover, an inordinate love for the ungainly nomenclature employed in the classification of crystals. Professor Lewis has imparted a still more chilling aspect to the subject by his rigid mathematical treatment throughout, and the book certainly forms a programme of serious work We observe that the notation for the crystal forms, the treatment by stereographic projection, and the anharmonic ratio of four tautozonal faces, with which the late Professor Miller's name is associated, have been adopted. Naumann's symbols, so expressive of the geometrical relations of the various rhombohedra and scalenohedra, are employed. The index is good, containing as it does so many names which are invaluable as a means of reference. Particular care has also been bestowed on the numerous figures, and the student's power of solving crystallographic problems may receive a great impetus through the prominence given to the methods used in making diagrams.

"The Strength of Materials." By J. A. Ewing, F.R.S. (Univ. Press, Cambridge.) Illustrated. Professor Ewing's book is remarkable chiefly for conciseness. He knows how to express in a nutshell, as it were, what is really necessary to be said, and does not pad his pages with theories which, like old machinery, have become loose in the joints. Consisting, as one would expect, very largely of so-called graphical statics, he handles the representation of forces by lines and their interpretation by formulæ with admirable skill, and a student who is fortunate enough to gain possession of this volume will have the "open sesame" to all those engineering problems immediately concerned with the nature and effects of stresses in the several parts of girders, bridges, beams, and other structures. It is not, however, a beginner's book. To keep pace with the Professor in the present treatise—a lecture-room treatment of the subject accompanied by laboratory and drawing office work—the student must have inured himself to the many difficulties which mathematics, elementary mechanics, and physics present, before he can hope to tilt with success at the windmills here erected. Apparatus as used at Cambridge is described and figured. Tension, torsion, crushing, shearing, and the means of obtaining their numerical equivalents—these, and the like, are plastic in the author's hands, and he has put them in attractive form for such as have completed the essential preliminaries.

There are always numbers of photographers who like to use a small apparatus but want to get a good sized picture; both these desires can be satisfied in the "Nydia," a neat folding put-into-the pocket camera which Messrs. Newman & Guardia have recently brought out.

BOOKS RECEIVED.

Prehistoric Times. 6th Edition. By the Rt. Hon. Lord Avebury. (Williams and Norgate.) Illustrated. 18s.

Directory for Science and Art Schools and Classes, S. and A. D., 1900-1901. (Eyre & Spottiswoode.) 6d.

Hygiene. By R. A. Lyster, B.SC. (Clive.) 2s.

Electric Batteries. Edited by Percival Marshall, A.I.M.E. (Dawbarn & Ward.) Illustrated. 6d.

The Proposed National Antarctic Expedition. By Wm. S. Bruce. (Pamphlet: reprinted from the *Scottish Geographical Magazine.*)

Feilden's Magazine. June, 1900. 1s.

A Little History of South Africa. By Geo. McCall Theal. (Unwin.) 1s. 6d.

In Birdland. By Oliver G. Pike. (Unwin.) Illustrated. 6s.

Comparative Anatomy of Animals. By Gilbert C. Bourne, M.A. (Bell.) Illustrated. 4s. 6d.

Chemistry: An Exact Mechanical Philosophy. By Fred. G. Edwards. (Churchill.) 3s. 6d.

Annales de L'Observatoire National D'Athens. Tome II. By Démétrius Eginitis, Directeur.

Results of Meteorological and Magnetical Observations, Stonyhurst College Observatory, 1899.

Etching on Metals.—Useful Arts and Crafts Series. (Dawbarn & Ward.) 6d.

Photography in Colours. By R. Child Bayley. (Iliffe.) 1s. net.

Leeds Astronomical Society—Journal and Transactions, 1899. (Wesley.)

Liverpool Observatory, Bidston.—Report of the Director, 1899.

Historical and Literary Essays. By Lord Macaulay. (Ward, Lock.) 2s.

The Story of Bird Life. By W. P. Pycraft. (Newnes.) 1s.

Electric Lighting. By A. A. C. Swinton. (Crosby Lockwood.) 1s. 6d.

Local Particulars of the Total Eclipse of the Sun, 1901, May 17-18. (Nautical Almanack Circular, No. 18.)

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ASTRONOMY WITHOUT A TELESCOPE.

By E. WALTER MAUNDER, F.R.A.S.

VI.—THE MILKY WAY.

THE short nights of midsummer do not in general give much opportunity to the Astronomer. But twice in the year the most wonderful of all celestial objects stretches itself across our English zenith and sweeps downwards to either horizon. This is that

> "Broad and ample road whose dust is gold
> And pavement stars, as stars to thee appear,
> Seen in the Galaxy, that Milky Way,
> Which nightly as a circling zone thou seest
> Powdered with stars."

Its sweep at midnight in mid-July is from the north eastern horizon where the constellation Auriga is just rising, through Perseus and Cassiopeia on to Cygnus in the zenith; descending again on the other side through Aquila, Serpens, Sagittarius and Scorpio to the horizon in the south-west. The second time when it crosses the zenith is at midnight in mid-December, when it sweeps upwards from the south-eastern horizon in Argo, between Orion and Gemini to the zenith now marked by the constellation Auriga; from whence it passes downwards through Perseus and Cassiopeia to the north-west horizon where the constellation Cygnus is setting.

The Galaxy is no modern discovery. Ptolemy of Alexandria has handed down to us a very full and precise description of it, and it has caught the attention and stirred the imagination of races even as savage as the Australian black fellows. It has been thought of as the roadway of the Gods by which they passed from their halls of eternal light, when they wished to visit this nether world of ours; or it is "Die Jakobsstrasse," the mystic ladder which the patriarch saw in his dream at Bethel, up and down which the angels moved.

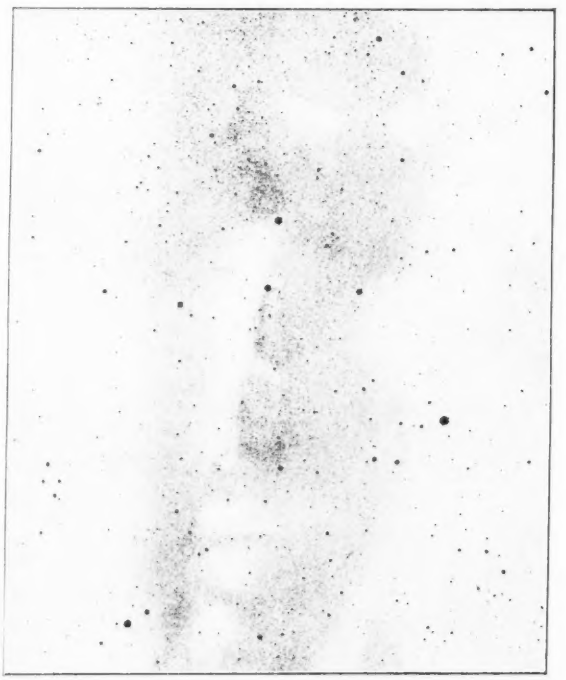
Ptolemy and the Greek Astronomers had recognized two leading facts concerning it. One, that it marked out a zone in the sky, the centre of which was nearly a great circle; the other, that it was not equal and regular everywhere but varied in different regions, in breadth, in brightness in colour, in distinctness, and especially that in some places it broke up into two distinct streams. So much therefore was known about it long before the invention of the telescope, and though it gives to our greatest telescopes their most gorgeous starfields, though in some portions it still defies the efforts of our most powerful instruments fully to resolve it, though its characteristic formations are only brought out when we are dealing with stars far fainter than can be individually detected by the unaided sight, yet the Milky Way as a whole is essentially a naked eye object.

The dwellers in cities and towns, smoke-veiled and flaring with arc lamps or incandescent lights, must abandon all hope of a really intimate knowledge with the delicate structure of the Milky Way. But there are many and many stations in this our island,—lone country houses, little villages,—upon which stars of the short dark summer night will shine down like silver points set in ebony. The faint twilight, visible all night long above the northern horizon, will not interfere with the darkness of the zenith and the south. The evasive moon recognizes that the season belongs of right to her more powerful brother, and either does not show herself at all, or timidly skirts the south as if anxious to escape notice. So though the summer hours of darkness are so few, sufficient of them may be utilized for so delicate a study as that of the Milky Way.

The reason why it is so pre-eminently a naked eye object is easily seen. The field even of a comet-seeker or any other telescope of wide-field and low magnifying power deals with so inconsiderable a fraction of the whole sky. It is impossible in the telescope to mark out the boundaries of the Way; to see where it radiates and divides; where it reunites and condenses again. It can only be examined piecemeal, a very small fraction at a time—"the wood cannot be seen for the trees." It is necessary, therefore, if we are to gain any adequate knowledge of the structure of the Milky Way as a whole, that we should supplement telescopic and photographic examination by the most careful and thorough scrutiny with the unassisted sight.

This is astronomical work of a high order of importance which has been very seldom adequately attempted. The names of Heis, Bœddicker, Easton and of a very few others, occur in this connection, and from the nature of the case, the difficulties of the work being great, it is most important that their observations should be continually repeated.

It is not my intention in these papers, either to describe what other observers have seen or to give any regular history or summary of observations. That has been done most excellently before. Nor do I wish to



Via Lactea. Borealis 1. Scutum-Cepheus.

describe what an observer might be expected to see for himself, since I fear in many cases the reader would content himself with the description. My intention is simply to give such merely general indications of the work which may be attempted and the manner in which it may be set about, that those who wish so to do may

themselves undertake observations which, so far as they are concerned, may be original.

Given the absence of the moon, a suitable time of the year, and a thoroughly dark clear night, and even the most casual observer will at once perceive that the Milky Way is a most complex object. In one place we find it broad, and diffused; in another it narrows almost to disappearance. Here the outline will be sharp; there it is fringed out into faint filaments. In some places it coagulates into knots and streaks of light; in others it is interrupted by channels of darkness. It is these details to which I trust that not a few readers of KNOWLEDGE will direct their attention.

At this present season I would specially invite attention to that region of which Gamma Cygni is the centre, and which extends from the borders of Cepheus to those of Aquila. Here begins that great rift in the Galaxy the interpretation of which is so essential to a true understanding of its meaning. Here too are seen numerous crossways and side-rifts, not so easily caught as the main channel, but which will be detected as the observer gains experience and skill.

As to the actual method of observation, the first essential is that the observer should be screened from all interference by artificial light. Here comes in the same sort of difficulty that is experienced in drawing the Zodiacal Light, a difficulty to be overcome in much the same manner. First of all the observer must learn thoroughly the principal stars of the district which he is examining; then perhaps the easiest method is for him to dictate to an amanuensis, close at hand, but the light of whose lamp is perfectly shielded from the observer. The latter then might describe the course with respect to the leading stars, of the various rifts or rays, and at the same time should add estimations of the relative brightness or darkness of each respectively. Another method would be to carefully plot the stars down upon a sheet of paper beforehand, which paper might be illuminated by a very faint ruby light, like that used in a photographic dark-room; and the outlines might be drawn on the paper with reference to the stars by its means. The light itself must of course be arranged to shine only on the paper not on the observer's face. It is possible that a card covered by luminous paint might also be useful in this work, but it is not a device which I have myself employed, and I think it would probably dazzle much more in proportion to the amount of assistance it gave than would the faint ruby light. If the luminous paint is used, I should be inclined to recommend either that it be used under a card in which holes have been punched to represent the stars or under a sheet of ground glass or tracing paper or cloth on which the stars have been indicated by black dots.

The beginner should bear in mind that though the Astronomer's rule is to note, that is to record, whatever shines *(quicquid nitet notandum)*, nevertheless that he must learn to see before he can record. The careful study therefore of the chosen region of the Milky Way for two or three nights before any drawing is made will not be thrown away, and it should not be forgotten that faint lights are best seen, not from the centre of the eye but from the side, by "averted vision," that is to say. On the other hand, directly the observer feels that he is beginning to get some acquaintance with his subject he should begin to record. The first attempts will no doubt cost some effort, and may prove disappointing, but skill in delineation as well as in detection will come with practice.

PLANTS AND THEIR FOOD.—IV.

By H. H. W. PEARSON, M.A.

AN ordinary fertile soil consists of 75 to 95 per cent. of mineral matter mixed with 5 to 10 per cent. of humus. The mineral particles are of different shapes (*v.* figure), and vary in size from a microscopic dust (clay) to grains large enough to form what we commonly call sand. In addition, there are usually present "stones," larger fragments of rock which form a reserve of mineral nutriment and by their slow decomposition enrich the soil; they are also of no little importance in keeping the soil beneath them moist, at the same time increasing its warmth, for they are quickly heated by the direct rays of the sun.

Soils are divided into numerous classes according to the relative amounts of clay and sand which they contain. A "sandy" soil, for instance, contains over 70 per cent. by weight of sand in addition to clay, lime and other mineral substances and humus. A "clay" soil is composed of the same constituents but in different proportions, half its weight at least consisting of mineral matter so finely divided as to be included under the term "clay." According to some interesting figures recently published by the agricultural authority of the United States, in a gramme-weight* of a sandy soil which contains only 4.77 per cent. of clay, there are about 2 million particles. In another case, a subsoil containing as much as 32.45 per cent. of clay, there are estimated to be 15 million particles in a gramme weight. If the surface-areas of all the particles in a given bulk of soil be added together we should expect the total to be very large. We are therefore not altogether surprised to learn that the average total surface-area of all the particles in a cubic foot of soil is no less than 50,000 square feet. If the soil be sandy, containing only about 2,000,000 particles to the gramme, the total surface area in a given bulk will of course be less than in a clay soil in which are a much larger number of smaller particles. The importance of such calculations as these is seen in dealing with the relation between the soil and the water which penetrates it.

If water in sufficient quantity is poured upon the soil in a flower-pot a part only escapes by the perforation in the bottom of the pot, the rest being retained by the soil. The amount which the soil is capable of holding depends mainly upon two conditions, of which the first is the presence of humus, which, as already pointed out, is a strong absorber of water and adds considerably to the moisture-retaining power of the soil of which it forms a part. In soils which contain only small proportions of humus, the physical properties—in particular the relative sizes—of their mineral particles are of far greater importance in determining their behaviour towards water. As is well known, when a solid is wetted by a liquid, a thin film spreads itself out over the surface, and adheres to it. As rain-water sinks into the soil it penetrates between the mineral particles, each of which becomes surrounded by a thin film of moisture which leaves the general stream and becomes for the time being a constituent part of the soil. It is obvious that the larger the total surface-area of the particles, or in other words the greater the number of particles contained in a given bulk of the soil the more water is thus retained. A clay soil, therefore, being composed of a greater number of minute particles holds more water than a sandy soil whose constituent particles are larger

* 1 gramme = 15·43 grains.

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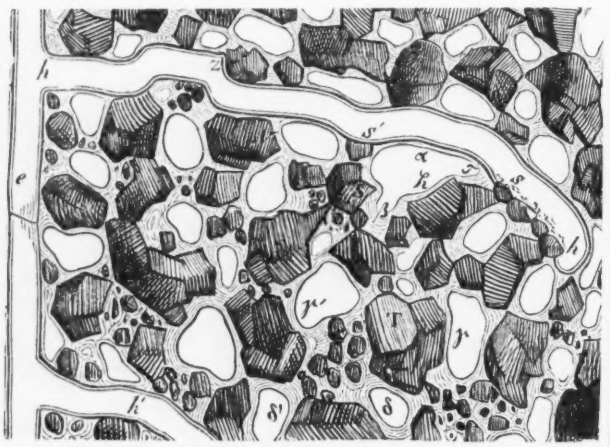
and fewer, and therefore have a smaller surface area. An excess of sand therefore renders a soil dry, and its vegetation suffers in a dry season; if, on the other hand, clay is too abundant the soil holds so much water that it is rendered cold, and being badly aerated becomes acid† and is not well suited to the growth of roots. A soil well adapted to support a thriving vegetation strikes the happy mean between these two extremes, and may have such a composition as the following:—‡

Sand	... ...	from 50 to 70	per cent.
Clay	... ...	„ 20 to 30	„
Lime	... ...	„ 5 to 10	„
Humus	... ...	„ 5 to 10	„

The water thus absorbed by the soil holds in solution various acids formed during the decay of vegetable remains and Carbon dioxide produced in the same process and also given off by growing roots.§ It is therefore a slightly acid liquid which dissolves such of the mineral constituents of the soil as are soluble and renders them accessible to the roots of plants. How great is its solvent action may be imagined when we consider that in a cubic foot of soil it is in contact with 50,000 square feet of mineral surface.



A Vertical Section through Soil, showing the external cells of a root (*e*) giving off root-hairs (h, h^1). The dark angular masses are soil-particles, each surrounded by a film of water (indicated by concentric lines). The light patches (α, β, γ, etc.) are air-bubbles. (After Sachs. Reproduced from Pfeffer's "Physiology of Plants"—Eng. Trans.—by permission of the Clarendon Press.)

The constituents of the soil then are inorganic and organic particles, water and air. The particles are surrounded by films of water which separate them from their neighbours. The water so held is in communication over wide areas, and as its dissolved contents are removed at one point by roots or other agents the deficiency is made good from the surrounding area. A plant therefore does not necessarily obtain the whole of its mineral food supply from the soil in contact with its roots, but is able to draw supplies from a wide area, the transport being effected by the soil-water. Air-bubbles entangled among the particles and their films supply the Oxygen necessary for the respiration of the roots: it is to be noted that this subterranean air differs considerably in composition from that above ground in that it contains a larger proportion of Carbon dioxide derived from the decay of vegetable matter in the soil.

The water which percolates through the soil is still further affected by the remarkable power which the latter possesses of withdrawing from solution certain substances which are dissolved in it. If some garden soil be placed in a funnel and a water-solution of common salt (sodium chloride) poured over it, the water which runs away contains less salt than the original solution. Some of it has been absorbed (or "fixed") by the soil. This property of the soil has been constantly used in obtaining drinking water from impure sources. When the Egyptian forces were besieging Cæsar in Alexandria (B.C. 47), they fouled the wells of the city with sea water. In the emergency, Cæsar caused pits to be dug in the sandy beach and the water which oozed into them from the sea was "not altogether unfit for drinking."‖ Bacon relating this incident says,¶ "Cæsar mistooke the Cause; For he thought that all Sea-Sands had Naturall Springs of Fresh Water. But it is plaine, that it is the Sea-Water; because the Pit filleth according to the Measure of the Tide: and the Sea-Water passing or Straining thorow the Sands, leauth the Saltnesse." This is a classical example of the fixation of dissolved substances by the soil, and is additionally interesting in that it received the notice of the great Elizabethan philosopher. Otherwise, however, it is not so good an illustration as might be wished, for sand is less powerful in absorbing substances from solution than almost any other soil; and of the substances which are removed from their solutions by soil, common salt is affected to a much less extent than are many other mineral compounds. Humus and clay soils possess this property in a very high degree, and in comparison with them the power of absorption possessed by sand is very small indeed. Potash, Ammonia, and Phosphoric Acid, and compounds containing them, are removed from their solutions by the soil to a much larger extent than are any other substances. Magnesia, Soda and Lime are also absorbed to some extent, while Sulphates, Chlorides and Nitrates are very slightly or not at all affected.

Nothing like a complete explanation of these interesting facts is at present forthcoming. The absorption of a salt from its solution by the soil is due to more or less compli cated chemical or physical changes the nature of which is but little known, and indeed need not here be considered. The fact which is of importance as regards the food supply of a plant is that certain substances, in particular Potash, Ammonia and Phosphoric Acid, important constituents of the mineral food of plants, are taken up by the soil from their solutions. In what form they are stored in the soil is not known but it is certain that in their "fixed" state they form a reserve supply. The soil-water, as we have seen, is a weak solution of the mineral food substances; as a small quantity of any of these is removed by the roots the deficiency is made good by a corresponding amount of the "fixed" substance becoming again freely soluble and in a condition to be taken up by the plant.

Over other substances, notably Nitrates, the soil has little or no control, and these are carried away by the drainage water out of the sphere of influence of the roots of land-plants. The existence of Nitrates in any quantity in any but an exceedingly dry soil is therefore an impossibility, a fact which leads to the consideration of

† The normal decay of organic bodies is interrupted on account of lack of oxygen; instead, therefore, of the simpler ultimate products of decomposition, there are produced complex vegetable acids.

‡ Fream. "Soils and their Properties."

§ KNOWLEDGE, May, 1900, p. 102, footnote §.

‖ Merivale. "History of the Romans under the Empire," II. (1873), 319.

¶ "Sylva Sylvarum" (1628), 1.

the sources whence the vegetable world obtains its Nitrogen.

It has already been noticed that protoplasm, the "living substance" of all organic beings, is composed of the complex Nitrogen-containing bodies which we call "proteids." Nitrogen, then, is a constituent of the protoplasm itself, to say nothing of other substances found in plants which also contain it; hence we must regard it as a food element of primary importance. In considering the assimilation of Carbon by plants, we saw that an important *rôle* played by vegetable life in the world's economy is the formation of complex Carbon compounds from Carbon dioxide, in other words the raising of Carbon from an inorganic to an organic state in which alone the animal is able to assimilate it. With regard to Nitrogen we find that plants play an equally important part. The animal can only assimilate Nitrogen when it is in the form of complex organic substances such as proteids. Plants make use of simpler organic compounds, inorganic substances such as Nitrates or even (the lower forms of vegetable life) of free Nitrogen itself. By the plant, the element or simple compounds containing it are built up into organic forms such as can convey Nitrogen into the animal system. The waste products of the animal body—living or dead—upon their decomposition, yield up the Nitrogen in simpler forms which are again ready to be assimilated by the plant.

A few plants—such, for example, as our British insect-eating Sundews and Butterworts—obtain part of their Nitrogen from the complex proteids and peptones of the bodies of their prey. In this respect, these and other insectivorous plants live after the manner of the animal, that is, they do not build up complex nitrogenous substances from simpler compounds, but make use of those which have been produced by other plants. They, however, form a very small proportion of the vegetable kingdom. Most higher plants, by which we mean those bearing green leaves and conspicuous flowers, obtain their Nitrogen from nitrates and compounds of Ammonia present in the soil, and of these the majority grow best when they are supplied with nitrates. It has been pointed out above that nitrates are very readily washed out of the soil by percolating water. In some experiments at Rothamsted it was found that in each of the four years between 1877 and 1881 an average of 41.81 lbs. of Nitrogen** per acre in the form of nitrates was washed out of the soil and escaped with the drainage water. If we consider that this amount of nitrogen (42 lbs. per acre per annum) would be sufficient to supply an ordinary crop of wheat or barley we shall realise how serious is the loss of nitrate from the soil which occurs with every fall of rain. It is clear, on the other hand, that water-plants growing partially or entirely immersed in natural waters—the accumulations of water which has drained over or through the land—must be well supplied with nitrates.

Since the loss of nitrate from the soil in any but a very dry climate is continuous, we must enquire by what means Nature meets the difficulty of supplying Nitrogen to that large portion of the vegetable kingdom which seeks it in this particular form. It has long been known that the passage of a lightning flash through the atmosphere is accompanied by a combination of Nitrogen and Oxygen of the air and a consequent production of small quantities—very small quantities—of nitrates. These are washed down into the soil and, until they are washed out again, are available to plants. The amount thus produced is, however, infinitesimal compared with the requirements of the world's green vegetation. Atmospheric electricity is, however, responsible for a much larger production of oxidised Nitrogen (nitrate) than results from the spasmodic discharges of thunderstorms. Wherever earth and air are in contact the air is at a slightly different electrical potential from the earth, and in consequence there is a continuous silent electric discharge between them. This discharge is accompanied by the chemical union of Nitrogen and Oxygen and the production of Nitrates. The amount formed in this way at any one place is of course exceedingly small, but the process occurs continuously over wide areas, and it is therefore not difficult to believe with M. Berthelot that an important contribution is thus made to the nitrate-demands of the vegetable world.

Probably, however, the most important of the natural agents in the formation of Nitrates are the numerous but little known microbes which inhabit the upper 9 to 18 inches of clay soils in prodigious numbers. It is probable that the power of oxidising atmospheric Nitrogen is not rare among these lowly organisms, but at present we know of only one which has actually been proved to possess it.†† The organism, which resides in the roots of Leguminous and some other plants, and enables them to make use of the free Nitrogen of the atmosphere, will be noticed when we are considering the functions of roots. Others of these soil bacteria are concerned in the production of Nitrates, not from the free element, but from those vast stores of combined Nitrogen which exist in the soil in the form of humus. It has been believed that the higher plants are unable to absorb and assimilate the complex organic Carbon—and Nitrogen—containing substances which are present in humus. As to this vexed question we are unable to speak definitely. Certain it is, however, that a vast army of minute workers are constantly employed in transfering certain of the products of the decomposition of humus into Nitrates. These bacterial labourers are divided into at least two classes. There are in the first place those which seize upon the compounds of Ammonia which result from the decay of humus, and oxidise them, producing in this way salts called Nitrites which, as their name implies, are related to Nitrates, differing from them in containing less Oxygen. These receive attention from another section of the bacterial inhabitants of the soil, which oxidise them further, the final product being Nitrates which contain Nitrogen in the condition required by the majority of the higher classes of the vegetable world.

We have noticed the principal known methods by which Nature provides for the Nitrate wants of the vegetable kingdom. Under natural conditions these agencies—and perhaps others also, as yet undiscovered—are sufficient to replenish the soil with oxidised Nitrogen—a replenishment which must be continuous to be effective owing to the rapidity with which Nitrates are removed from the soil by rain-water. But under the artificial conditions of cultivation the equilibrium of these relations is upset. In removing from the land his annual crop, the farmer carries off the greater part of the year's supply of potential humus whence the soil looks to be provided with Nitrates—by the action of the soil-bacteria—for the coming season. Hence arises the necessity for the application of manures containing Nitrates. The supply of these manures becomes

** Equal to 254 lbs. of nitrate of soda ($NaNO_3$).

†† Winogradsky. *Comptes Rendus*, 1894, T. CXVIII., p. 353.

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smaller, and the need for them larger, every year, a fact which has given rise to disquieting prophecies of coming Nitrogen-starvation and the consequent failure of the world's supply of wheat.‡‡

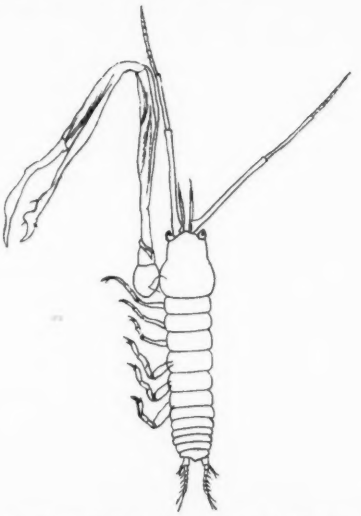
THE KARKINOKOSM, OR WORLD OF CRUSTACEA.

By the Rev. THOMAS R. R. STEBBING, M.A., F.R.S., F.L.S., F.Z.S., *Author of "A History of Crustacea," "The Naturalist of Cumbrae," "Report on the Amphipoda collected by H.M.S. 'Challenger,'" etc.*

FISH-BEARS AND THEIR KINDRED.

EMERSON was extremely worried by Carlyle's reiterated use of the fantastic expression "gigmanity." Chrysostom's congregation grew tired of his orations against swearing, even while they continued to swear. The persevering student may weary of being told that a woodlouse is a crustacean, before he has become conscientiously convinced that it is one. The old writers were far from accepting the fact. They pertinaciously kept the members of the group apart, under names which to this day have not been discarded, though employed now in a very restricted application, these names being the Greek Oniscus, a little donkey, and the Latin Asellus, which likewise means a little ass. This asinine herd, however, included and excluded many creatures which should have been respectively outside it and within. The woodlouse may be taken as a sort of exemplar or figure-head, to introduce and typify the enormous, diversified, world-wandering order of the Isopoda. The name, meaning equal-footed or like-footed, was coined by Latreille, with a view not to the whole of the order as it is now known, but to a limited number of familiar species, which really have the character implied in the designation. In truth, there are to be found in this, as in many other orders of crustacea, combinations of feet which exhibit no monotony of shape, and are almost grotesque in inequality of size.

The retention of the name, in spite of its being not completely applicable, is a matter of convenience, just as human families retain names such as Webster and Talboys, when their members in general have ceased from weaving the warp and the woof, or from shaping the timber of the forest. Peers and popes and places on a map are allowed to confuse their identity by an unregulated change of name, but science is opposed to such a proceeding. A name is not a definition, and when lawfully given it is not to be lightly altered even on pretence of improvement. The application may be expanded or contracted, just as Rome and Romney may pass through alternations of little and large without ceasing to be Rome and Romney. The Isopoda began with a few genera and species, which during this century have been multiplied into a great horde. Of this number it must be acknowledged that some are separated from the rest by rather trenchant differences. There is a group in which the heart and breathing apparatus are near the head instead of in the caudal region. To these perhaps we ought to apply a name invented by Dana, Anisopoda, which simply means Not-Isopoda. There is an objection to negative names on the ground of their indefiniteness. In this case, for instance, it may be alleged that, apart from the Isopoda, everything in heaven and earth is "Not-an-Isopod." That is true, yet such a word as Anisopoda serves, better than the more recently proposed Tanaidacea, to remind us that the objects so named were once upon a time regarded as Isopoda, and that they have at least some superficial characters in common with that order.



Leptochelia forresti, Stebbing. Feet of right side omitted.

Elaborate details of the structure cannot be given here, but a representation is offered of a species from the family Tanaidæ, without prejudice to the question whether this family, and its companion, the Apseudidae, should be counted as belonging to the order Tanaidacea, the section Anisopoda, or the tribe of the Isopoda chelifera. The species figured, *Leptochelia Forresti*, is found in the West Indies. The enormous claws signalise its masculine sex. They need not inspire alarm, as they are attached to a body only a quarter of an inch long, with jaws as gentle as those of any "sucking-dove."

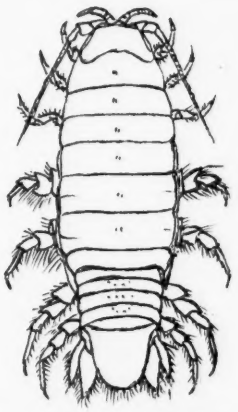
Passing on, then, to the section of the Euisopoda, that is, the good, the orthodox, the genuine Isopoda, which are accepted always, everywhere, and by everybody, we find a further sub-division into tribes, which may have unforeseen consequences in the future. The natural man is distinguished from the naturalist in this way. The natural man, having with pains and reluctance got into his head a scheme of classification for some group of objects, wishes to have that scheme permanent and unalterable. The naturalist, on the other hand, is aware that fixity of classification means stagnation of enquiry. The more objects he knows about and the more he knows about the objects, the less possible does it continually become for him to fit the new facts into the old framework. Hence come re-arrangement, the disruption of old ties, the formation of fresh alliances, and science which, as above explained, is so jealous to preserve the established names of things, must still be fertile in new terms to express their newly discovered relationships.

Of the land isopods, embraced at present in the tribe Oniscoida, mention has been made in earlier essays (KNOWLEDGE, Vol. XXI., p. 106, Vol. XXII., p. 285). The insularity of our island is emphasized by the fact that as yet only nineteen species of this group are known in England, Wales, and Scotland. Ireland has a still smaller number, but includes therein the active *Trichonisus vividus* (Koch), not recorded from any British locality on this side of the Irish Channel. In other parts of the world the species are very numerous,

‡‡ Sir Wm. Crookes. Presidential Address to the British Association. Bristol, 1898. "The Wheat Problem." London, 1899.

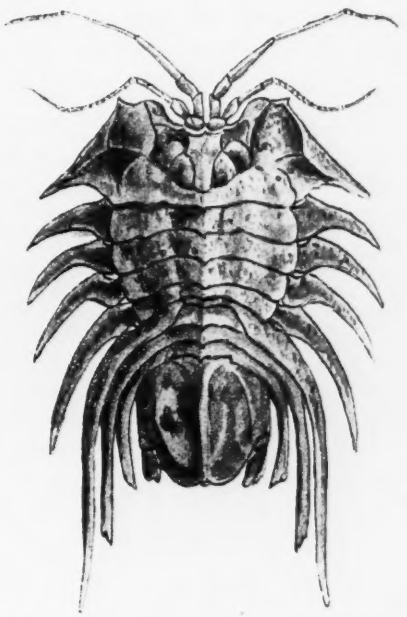
and though some are local within narrow limits, others vie with the Anglo-Saxon race itself in range of travel. Their own little legs, though fourteen in number, and occasionally displaying great agility, could scarcely carry them very far within the lifetime of an individual. Some species, which seem not only to attend but to precede the footsteps of man in remote regions, have probably covered the larger distances as an uninvoiced portion of the merchant's exports or the traveller's baggage, and then by making short excursions from the point of arrival have been enabled to assume the attitude of old inhabitants.

Nearest in general appearance to the terrestrial isopods are the Sphæromidæ, which belong to a different tribe, the Flabellifera, a highly important and interesting but rather a miscellaneous group. In it the uropods or tail-feet are lateral, forming with the telson a flabellum or fan, whereas in other isopods (except the Valvifera) they are terminal. The Sphæromidæ till recently were only known as marine. Now they have been obtained from the fresh water of warm springs and inland caverns, the passage from salt water to fresh being, as one may suppose, the intermediate step to a truly wonderful change, from aquatic to subaerial existence. Human beings who try making this change in the reverse order usually find five minutes over long for the experiment. But some of the land isopods are far less sensitive, for I have found a Porcellio immersed on the side of a lock and making no attempt to leave the water, yet quite lively when removed from it, and a recent experiment has shown that a *Porcellio scaber* can remain under water for four or five hours without material inconvenience.



Cirolana borealis, Lilljeborg. From H. J. Hansen.

In the same tribe with the Sphæromids are the Cymothoids, of which, if one were a literary fish, one would write with a kind of horror, on account of the appalling diligence which these so-called fish-bears devote to ichthyology. Not contented with persecuting ling and haddock, cod and halibut, they assail with equal fearlessness dog-fish and shark and tunny. An extraordinary feature in the life of some of the Cymothoids is the virtual change of sex which is said to occur, enabling the father of one family to become in turn the mother of another, as though the ordinary marital arrangements were not sufficient to perpetuate their malicious brood. Those, like the Ægidæ, which lead a parasitic life, are furnished with sharp hooked claws for clinging, and with mouth-organs modified for piercing and tearing the skin of their hosts. In the nearly allied Cirolanidæ the claws are not powerfully uncinate, because these species are more vagrant. Their jaws are adapted for biting rather than piercing. They are not less enamoured of a fish diet than the Ægidæ, and they make their meals impartially of the living and the dead. The celebrated Kröyer once found a large codfish riddled by a swarm of *Cirolana borealis*. He hastily secured some in his closed hand, but with equal haste let them go again, for they bit him barbarously and gnawed at his naked flesh without remorse. Nothing could more painfully show the unscrupulous character of these creatures than that they should dare "to bite so good a man," who was grabbing them purely in the interests of science.

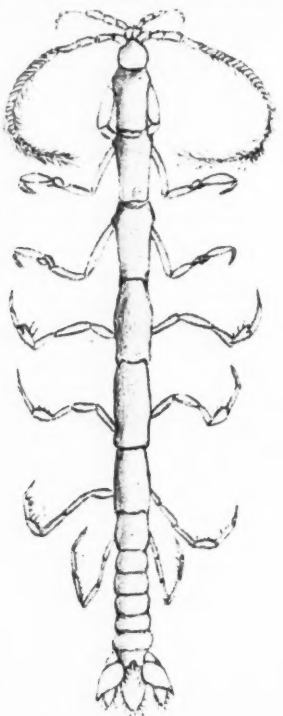


Serolis bromleyana, v. Willemoes Suhm. The feet omitted. From the "Challenger" Isopoda.

A passing notice must suffice for the flattened sand-burrowing Serolidæ, a family, so far as known, almost confined to the southern hemisphere, but ranging from shallow water down to a depth of two thousand fathoms. A comparison of the species *Serolis bromleyana*, v. Willemoes Suhm, with the species *Anthelura elongata*, Norman, from the family Anthuridæ, will show what strange contrasts of shape are possible within a single tribe of the Isopoda. In the Anthuridæ the great comparative length and almost linear form of the trunk may first appeal to the attention, but there is more to engage it in the head and the tail, small as they both are. The peculiar folding of one branch of each uropod over the telson produces a certain resemblance to the calyx of a flower. This suggested for the first formed genus the poetical name *Anthura*, meaning flower-tail. At the other extremity the head forms a rather difficult subject for study. At the first glance it might be supposed to vary little in the different genera. But this is not the case. The small closely compacted mouth-organs show important distinctions. In some of the genera they are evidently for perforation and suction, but in others their mode of operation is not so clear, nor

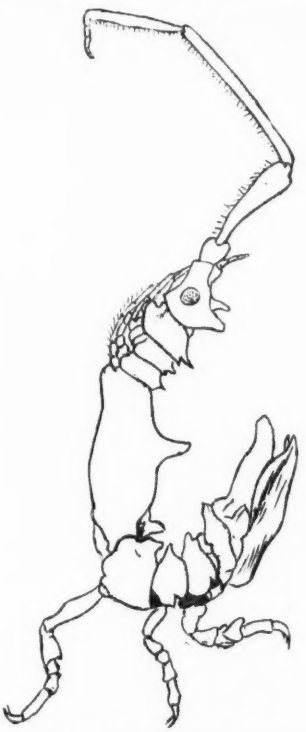
in either instance is it known upon what objects they operate. To serve their private ends they very likely use the moral or intellectual quality nowadays described as slimness, in suitable accordance with their slenderness of form. Of the equally curious family Gnathiidæ, completing the tribe Flabellifera, discussion must be held in reserve.

Of the Valvifera a specimen has been already figured (KNOWLEDGE, Vol. XXI., p.3). The name of this tribe has reference to the uropods, which fold like valves, or rather meet like a pair of folding-doors, so as to enclose and shelter when necessary the natatory respiratory pleopods. In regard to *Anthura* it was mentioned that the uropods folded over the telson. Here they fold under it, and by a curious modification this which is the last pair of appendages looks as if it might be the first, because it covers the five pairs of pleopods which in order of attachment all precede it. In the family Idoteidæ the legs show tolerable uniformity, but in the co-tribal family Astacillidæ there is often strong diversity between the set consisting of the first four pairs and that consisting of the last three. The hinder group are of normal pattern, adapted for clinging to seaweed or other suitable marine objects. The anterior set are slender and feeble and fringed with setæ. These four pairs are close together and close to the mouth, and are no doubt much concerned with the food-supply. But the first seizure of



Anthelura elongata, Norman.

prey is said to be accomplished by the powerful lower antennæ. In this case, however, the prey will not consist of sharks and dog-fishes, but of minute organisms, such as can be passed on from the antennæ to the setose legs and held within their network of hairs or setæ at the disposal of the selective jaws. The long antennæ in this family have another function beside that of grasping prey. They form a sort of perch to which rows of young ones have repeatedly been found clinging, like wind-waving articles on a laundress's clothes-line. One observer has recorded that "the parent neither testified impatience of their presence nor seemed to suffer any

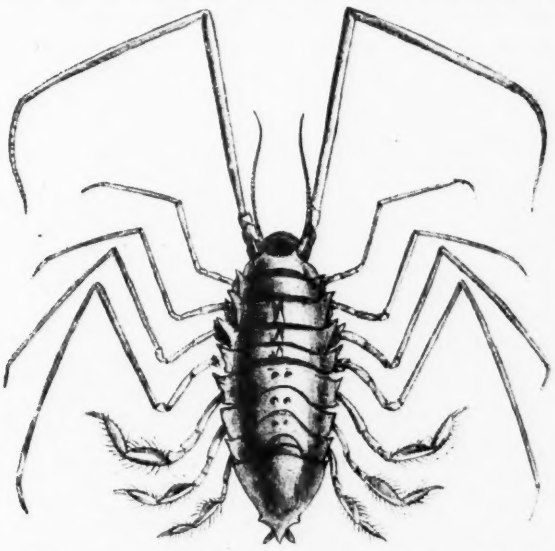


Astacilla damnoniensis, Stebbing.

inconvenience under the burden." The same observer, however, believed that with rapidly advancing growth the young "certainly proved an annoyance which was ultimately fatal." That the mother either invites or has no wish to hinder the presence of her little ones in so peculiar a situation is evident, for otherwise her long antennæ would be at once and instinctively passed between the fringing hairs of the front limbs, to be cleared, as in this way they habitually are, of encumbering objects. But the habits of crustacea quite forbid the supposition that the mother would permit the rising generation after birth to cause her serious inconvenience, when a simple bending of her antennæ would enable her to brush them off or eat them up.

Omitting from this sketch the strange parasitic tribe of Epicarida or Bopyrida, to which some allusion has been previously made (KNOWLEDGE, Vol. XXII., p. 138), we must give a concluding paragraph to the Asellota. In these the uropods are terminal instead of lateral, and in the female the first pleopods are usually consolidated into an opercular plate, thus fulfilling an office performed by the uropods in the Valvifera. Also in the female of the Asellota the second pair of pleopods is always wanting. This tribe includes the extremely common fresh-water species, *Asellus aquaticus* (Linn.), in which the feet are of a fairly uniform pattern. On the other hand, it also includes some of the rarest and strangest species of the whole order Isopoda, and some to which that name by its meaning is the least applicable, inasmuch as the feet show very exaggerated

differences of size and shape. An example convenient for illustration is afforded by *Eurycópe novæ-zelandiæ*, Beddard, in which it will be seen that the fourth pair of



Eurycópe novæ-zelandiæ, Beddard. From "Challenger" Report.

limbs are about thrice as long as the seventh pair. The generic name, signifying broad-oars, refers to the flattening of the penultimate and ante-penultimate joints in the hinder set of limbs; and this widening of the blades is carried in some species to a far greater extent than in the one here figured.

It may seem disproportionate to have given a whole chapter to the Isopoda, which to some readers must still seem an obscure, insignificant and unimportant order. A whole chapter has only sufficed to indicate the barest outlines of classification, the most obtrusive differences here and there in habits and outward form. The internal structure and the minutiæ of the ever varying mouth-organs have been left on one side, with much else. The fact is that the explaining of all that is known on the subject of this chapter would expand into a volume, the exploring of all that is unknown might occupy, amuse, and dignify a lifetime.

Microscopy.

By JOHN H. COOKE, F.L.S., F.G.S.

At a recent meeting of the Manchester Microscopical Society Mr. M. L. Sykes contributed a note on the methods that Mr. C. F. Rousselet employs when preserving and mounting organisms so that they shall retain their natural forms with their colours, muscles, etc. Mr. Rousselet exhibited a number of microscopical preparations of Rotatoria at the International Zoological Congress at Cambridge, which claimed special notice for their beauty and the success of the methods he had adopted. Rotifera cannot be killed suddenly, by any known process without contracting violently, and losing all of their natural appearance. To kill and preserve them with their cilia fully expanded and in their natural condition Mr. Rousselet first narcotizes them with a solution consisting of 3 parts of a 2 per cent. solution of hydrochlorate of cocaine, 1 part of methylated spirits, and 6 parts of water. The Rotifers should first be isolated in a watch-glass and clean water, and a drop or two drops of the solution added at first, after five or ten minutes another drop should be added, and afterwards drop by drop and very slowly until the animals are completely narcotized. They may then be killed and fixed by adding one drop of an eighth per cent. to a quarter per cent. solution of osmic acid. To clear from the solution they must be washed several times, and then transferred to a 2½ per cent. solution of formaldehyde, and should be mounted in this fluid in hollow ground glass slips. The objects have all the appearance of living animals, the colours, internal structure, and outward form being beautifully preserved in situ.

The current issue ("Zoology") of the "Journal of the Linnean Society" contains, among other articles of interest to the microscopist, a contribution by Mr. H. Wager on "The Eye Spot and Flagellum of Englena viridis,' and a paper by Mr. H. M. Bernard on "The Structure of Porites."

In a record of observations on the microscopic life of Arctic regions, Dr. Levin states that air from numerous localities showed only a few moulds. In water from the sea-surface bacteria were always found, but in very small numbers—perhaps one thousand to a quart; while water from glaciers, snow streams, ice and melted snow, also gave evidences of bacteria in small numbers. In water from the deep sea these organisms were more abundant than on the surface. With the exception of a single species of bacterium found in one bear and two seals, the intestinal contents of the white bear, seal, shark, eider duck, and other Arctic vertebrates were absolutely sterile, but bacteria were almost invariably present in the lower marine animals. These observations on germ-free intestines are of special importance and interest, as they confirm the idea of Pasteur and a few others that bacteria are not essential to digestion.

It is a curious fact that among the impurities that have been detected in calcium carbide are microscopic diamonds. These gems are so exceedingly small as to be of no commercial value, but they accentuate the fact that carbon in the crystalline condition can be produced artificially, and give reason to the assumption that some day it will be possible to produce diamonds of a size sufficient to be marketable.

In his Presidential address to the Quekett Society Dr. Tatham alluded to the difficulties attending the use of realgar as a mounting medium. Its high refractive index makes it most useful, but its disadvantages are many and serious. The fusion of the material which is necessary for the mounting process requires the application of great heat. This liberates intensely poisonous fumes, and frequently so distorts the valves of the diatoms that they are seldom found to lie flat on the cooling of the slide. The colour of the finished mount is a deep yellow, and this seriously detracts from the value of the mount for critical examination. This last defect may be partially rectified by the use of suitably coloured screens, of which a polished plate of bright blue glass has been found to be best adapted in aiding in the resolution of difficult tests.

The Cambridge Scientific Instrument Company are introducing an improved model of their well known rocking microtome. Among the advantages that they claim for the new form is the possibility of cutting sections to any required degree of thinness without the risk of the sections either varying in thickness or of being torn on the upward movement of the object.

In the epidermis of man and mammals Professor L. Ranvier has recognised seven distinct layers, which are described to the Royal Microscopical Society as stratum germinativum, fila mentosum, granulosum, intermedium, lucidum, corneum, and disjunctum, in the order of their development. The limits are well defined, each layer having distinct physical characters and chemical reactions. These layers are not formed by special elements, however, and a cell originating in stratum germinativum becomes changed and passes into stratum filamentosum and so on through the series.

Mr. J. E. Stead has recently published the results of the work that he has done on the microscopic structure of metals. Experience has made it easy to cut, grind, polish, and etch ordinary metals and alloys, and specimens can now be prepared for the microscope in a few minutes. Mr. Stead's work has yielded some unexpected results. In a recent demonstration pig-iron was shown to have its constituents gathered into separate centres, the carbides being in isolated silvery crystals, while the phosphorus and sulphur compounds were each distinctly separated. A brilliantly polished piece of white pig-iron, containing carbon, sulphur and phosphorus, was then heated until it became purple. Under the microscope the constituents were found to have diverse colours, the iron being of a fine sky blue, the carbides an orange colour, the phosphides a pale brown yellow, and the sulphides a slaty blue. This method of identifying phosphides is a new discovery which will be of great value to iron manufacturers as a simple means of telling whether iron contains phosphorus. The microscope shows that alloys, instead of being homogeneous, as have been thought, are built up of various crystals, and is likely to prove of practical service to metal workers in many ways.

The acetylene flame may be rendered monochromatic by the interposition of a screen of cobalt blue glass between the light and the substage condenser.

The principal uses of a light filter in photomicrography are for the correction of the objective, the increase of contrast in the image,

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and the increase of resolving power. Dr. S. Czapski has shown that the greatest resolving power is obtained by using light of short wave length, even the ultra-violet. This is due to the fact that the blue end of the spectrum has the shortest wave length, and the limit of resolving power is one-half of the wave-length of the light used.

In the course of his presidential address to the Quekett Society, Dr. J. F. W. Tatham drew attention to a mounting medium consisting of piperine and bromide of antimony, with which he has obtained very satisfactory results when examining lined tests. The mixture is prepared by combining three parts by weight of piperine and two of antimony bromide, by gently fusing the mixture over a spirit lamp, care being taken not to raise the temperature more than is necessary or it will char and discolour. After the diatoms have been spread on the cover glass in the usual way, a small portion of the mixture is placed between the cover glass and the slide, and gently fused until a thin film of it unites the two surfaces. When the medium is set it must at once be protected from the air, otherwise the salts will decompose. To effect this solid paraffin should be allowed to run between the cover glass and the slide, and the whole finished off with a circle of Hollis's liquid glue.

[All communications in reference to this Column should be addressed to Mr. J. H. Cooke at the Office of KNOWLEDGE.*]*

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

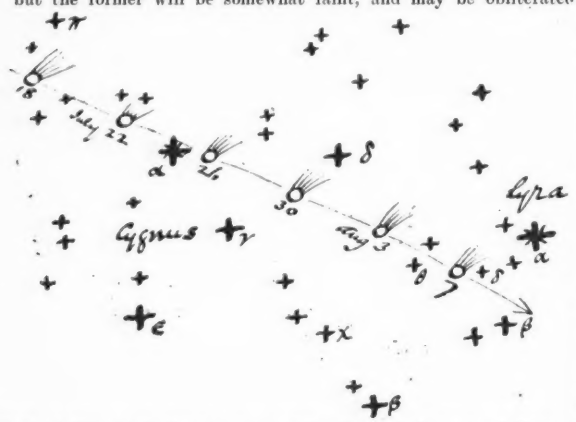
GIACOBINI'S COMET.—This object will be favourably visible in July, passing rather quickly through the constellations of Andromeda, Lacerta and Cygnus. It will be nearest to the earth at the end of the third week in July when it will be about twice as bright as it appeared on the night (January 31) of its discovery. The following is an ephemeris by Berberich (Ast. Nach. 3636) for Berlin, mean midnight:—

Date.	R. A. h. m. s.	Dec. ° ′	Distance of Comet in Millions of Miles.
July 2 ...	23 36 32	+ 42 31	125
„ 6 ...	23 12 47	+ 44 21	119
„ 10 ...	22 44 43	+ 45 52	115
„ 14 ...	22 12 29	+ 46 51	111
„ 18 ...	21 37 4	+ 47 7	109
„ 22 ...	21 0 16	+ 46 31	108
„ 26 ...	20 24 19	+ 45 0	109
„ 30 ...	19 51 16	+ 42 42	110
Aug. 3 ...	19 22 21	+ 39 51	113

At noon on July 25 the comet passes 44′ N. of Alpha Cygni, and with a very low power may be seen in the same field of view of a telescope on the nights of July 24 and 25. The position of the star (January 1, 1900) is R.A. 20h. 38m. 1s., Dec. + 44° 55′, while the places of the comet are—

July 24, R.A. 20h. 42m. 2s., Dec. + 45° 52′
„ 25, „ 20h. 33m. 6s., „ + 45° 27′

It will be interesting to view the comet and star if possible, but the former will be somewhat faint, and may be obliterated



Path of Giacobini's Comet amongst the Stars of Cygnus and Lyra, July 18—August 7, 1900.

in the glare from the star. The comet should be looked for with the star out of the field, and then the experiment can be afterwards tried as to whether both objects are visible together.

COMET 1892 II. (DENNING).—M. Fayet, in "Bulletin Astronomique," for March, gives the result of his researches as to the original orbit of this comet. M. Steiner has discussed (Ast. Nach. 3472) the present form of orbit, and concluded that it was hyperbolic. The comet was observed during the 10 months from March 18, 1892, to January 20, 1893. M. Fayet's investigations show that it was originally revolving in an elliptical orbit with excentricity equal 0.998406.

FIREBALL OF MARCH 28.—Prof. A. S. Herschel has compared the various observations of this brilliant object and finds that the most probable radiant was at 182° + 41°, and the height of the meteor about 60 to 38 miles above Kent. But the descriptions of the path by the various observers are inconsistent and lead to different results according to the interpretation put upon them.

FIREBALL OF MAY 5, 8H. 20M.—A very brilliant meteor was noticed by many persons in the strong twilight of May 5, but, as in the case of the fireball of March 28th, the accounts are somewhat discordant and incomplete as regards necessary details. The following are extracts from a few of the reports already published:—

NORTHANTS—Magnificent meteor, considerably larger than Venus. Appeared in S.E. sky, and sailed along the S. sky, crossing the meridian at about the altitude of the celestial equator, and finally bursting 30 degrees S.E. of the moon. Duration 5 or 6 seconds. "It looked like a runaway moon charged with colour."

ST. ALBAN'S, HERTS.—Meteor 4 or 5 times more brilliant than Venus. It was first seen about 10 degrees S. of Arcturus and disappeared about 4 degrees N. of the moon. Duration 2 or 3 seconds. Sky partially cloudy.

BISHOP'S STORTFORD.—Meteor of most startling and brilliant nature spread itself over the zenith. It had a tail 6 degrees in length.

HANDSWORTH, BIRMINGHAM.—Unusually bright meteor in the E. part of the heavens, travelled slowly from N. to S., appearing to take an upward course of about 45° with the horizon.

SYSTON.—"A great luminous ball of fire" seen leaving a trail of light behind it, and moving from E. to W. in an almost horizontal line.

BRIGHTON.—"Extraordinarily brilliant meteor visible towards the N.E. It swept along for some seconds, now hidden behind clouds, now shining out in the intervals towards N.W. where it disappeared."

EBBW VALE.—Fine greenish meteor moved across the S.E heavens very slowly from S. to N., its path being horizontal.

LIDLINGTON, BEDS.—The body of the meteor was of large size and very brilliant; the tail was of great length. Its course across the sky from N.E. to W. occupied 3 or 4 seconds.

POTTER'S BAR.—First seen in the direction of Arcturus and passed from S.E. to N.W. by W. Sailed across the zenith, and gave the impression of descending rapidly earthwards, the head exploding quite low down.

OXTON, CHESHIRE.—Fine meteor due S. when first seen, and moving slowly towards S.W.; not more than 25 degrees above horizon.

BIRMINGHAM.—Brilliant meteor, twice as large as Venus, "appeared rather low down in E. and was going almost due S." Another observer says it travelled in a horizontal line from E. to W. for about 30 degrees.

WALSALL.—Very brilliant object gliding gently across the heavens and putting Venus completely in the shade.

There are some other accounts. The observers generaliy describe the object as extraordinarily luminous, and moving rather slow'y in a horizontal path from E. to W. across the S. sky. The real path of the fireball was from about 64 miles over Canterbury, Kent, to 43 miles over Hungerford, Berks. Its length of course was at least 112 miles, and velocity about 20 miles per second. The radiant point was a few degrees above the E. horizon at 245° + 5°, but these deductions are mere approximations.

THE COMING OF THE PERSEIDS.—The last 12 nights of July will be almost free from moonlight, and an excellent opportunity will be afforded for observing early Perseids. They certainly begin to arrive in the third week of July, and it is important that the radiant point of the shower should be determined on every night from about the middle of July to the middle of August. Plenty of observations have accumulated for the first half of August and what we now require is a large number of materials for the last half of July. For this purpose the sky should be watched during the whole night, and the path-directions of the swift streak-leaving meteors from the regions of Cassiopeia and Perseus recorded with great accuracy. The positions of the radiant as deduced from the writer's observations in and since 1869 are as follows:—

	α °	δ °		α °	δ °
July 16 ...	16·6	+ 49·8	July 31 ...	33·2	+ 54·4
„ 19 ...	19·7	+ 50·9	Aug. 3 ...	36·7	+ 55·2
„ 22 ...	22·9	+ 51·9	„ 6 ...	40·2	+ 56·0
„ 25 ...	26·2	+ 52·8	„ 9 ...	43·8	+ 56·8
„ 28 ...	29·6	+ 53·6	„ 12 ...	47·5	+ 57·5

HEIGHT OF A METEOR.—Real paths have been computed at various times for meteors belonging to nearly all the chief showers of the year. But the rich shower of Aquarids discovered by Lieut.-Col. Tupman while cruising in the Mediterranean in 1870, and supposed to present an orbital resemblance to Halley's comet, had never supplied a doubly observed meteor the real path of which had been computed. At last, however, a pair of good observations are forthcoming. Prof. A. S. Herschel while watching the sky at Slough on May 3 at 13h. 57m. saw a very long-pathed shooting star travelling from 291° + 25° to 176° + 15° in 6½ or 7 seconds, and varying in magnitude from 5 to 2½. Mr. J. H. Bridger, of Farnborough, was watching the sky at the same time and recorded a meteor of 2nd mag. shooting from 300° + 36° to 179° + 34° in 4 seconds. The end was not well seen as a tree partially interrupted the view. Prof. Herschel's observed path extends over 105 degrees, while Mr. Bridger's covers 90 degrees. Prof. Herschel carefully noted the object as it sailed from Beta Cygni to Beta Leonis, and describes it as leaving a streak visible for one second. On comparing the observations it is found that, slightly altering the Farnborough end point (the view of which was very imperfect), they are in satisfactory agreement and enable the real path to be derived as follows:—

Height at beginning	54 miles, near Sevenoaks, Kent.
Height at ending	49 miles, 9 miles south-west of Cardiff, Bristol Channel.
Length of path	155 miles.
Velocity per second (adopting 5½s. for duration)	28 miles.
Radiant point	337° ± 0°.

The meteor therefore pursued a very long and almost perfectly horizontal path from east to west, the radiant having but just risen in the east. It is interesting to note that in the "British Association" report for 1875, p. 232, Prof. Herschel gave the date of nearest approach of the orbit of Halley's comet to the earth as May 4, the radiant point as 337° ± 0°, and the meteoric speed as 41 miles per second. The latter element differs widely from the 28 miles per second found for the recent meteor, but its original velocity in space must have been greatly retarded by the resistance of the earth's atmosphere during its very extended flight.

THE FACE OF THE SKY FOR JULY.

By A. FOWLER, F.R.A.S.

THE SUN.—On the 1st the sun rises at 3.49 and sets at 8.19; on the 31st he rises at 4.23 and sets at 7.49. The earth is at its greatest distance from the sun on the 2nd at 1 P.M., the sun's apparent diameter then being 31' 30".6.

THE MOON.—The moon will enter first quarter at 0.14 A.M. on the 5th; will be full at 1.22 P.M. on the 12th; will enter last quarter at 5.31 A.M. on the 19th; and will be new at 1.43 P.M. on the 26th.

The following are among the more interesting occultations during the month:—

Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
July 8	Delta Scorpii	2·5	11.24 P.M.	160	136	11 54 P.M.	207	180	11 22
,, 9	24 Ophiuchi	5·6	10.50 P.M.	68	57	0.2	290	268	12 22
,, 11	33 Sagittarii	6·0	10.18 P.M	126	138	11.10 P.M.	212	215	14 21
,, 12	Xi(2)Sagittarii	3·5	0.19 A.M.	110	103	1.18 A.M.	219	202	14 23
,, 14	c^2 Capricorni	5·2	9.43 P.M.	13	48	10.17 P.M.	306	339	17 21
,, 16	16 Piscium	5·6	11.3 P.M.	16	54	11.42 P.M.	294	330	19 22

THE PLANETS.—Mercury is an evening star, at greatest eastern elongation of 26° on the 4th, and near inferior conjunction at the end of the month.

Venus is in inferior conjunction on the 8th, after which she will be a morning star, arriving at a stationary point in Gemini on the 30th.

Mars is a morning star, in Taurus, rising about 1.30 A.M. on the 1st, and shortly before 1 A.M. on the 31st.

Jupiter may be observed up to midnight. He is near Beta Scorpii during the early part of the month, and is in conjunction with the moon, 1° 35' to the north, at 1 A.M. on the 9th. On the 15th the apparent diameter of the planet is 39".4. The satellite phenomena are most interesting—On the 1st (11.39), 3rd (8.55—11.2), 4th (9.2—11.16), 6th (11.23), 10th (8.48—12.49), 11th (10—12.13), 12th (10.25), 17th (8.37—11.10), 19th (9.5—12.20), 20th (8.30—9.35), 24th (8.7—10.8), and 27th (8.7—11.30).

Saturn may be observed throughout the greater part of the night, in the western part of Sagittarius. He will be on the meridian at 11.27 on the 1st, at 10.28 on the 15th, and at 9.21 on the 31st. On the 9th the polar diameter of the ball will be 17", and the outer major and minor axes of the ring respectively 42".5 and 18".9. The northern surface of the ring is visible.

Uranus is above the horizon from the beginning of the evening up to midnight throughout the month. He remains a little to the south-east of Omega Ophiuchi.

Neptune is not observable.

THE STARS.—About 10 P.M., at the middle of the month, Perseus, Andromeda, and Cassiopeiæ will be in the north-east; Cygnus and Pegasus in the east; Aquila in the south-east; Lyra nearly overhead; Corona, Libra and Virgo in the south-west; and Ursa Major in the north-west.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of June Problems.

No. 1.

(B. G. Laws.)

[We much regret that, last month, this problem was incorrectly diagrammed. The White Knight at QRsq should be a White King.

The problem is reprinted below; solvers who guessed the mistake need not trouble to repeat their solutions, which will be acknowledged, with any others, next month.]

No. 2.

(W. H. Gundry.)

1. Kt to Kt3, and mates next move.

CORRECT SOLUTIONS of No. 2 received from W. H. Brandreth, W. de P. Crousaz, G. A. Forde (Capt.), Alpha, K. W., H. Le Jeune, J. Baddeley.

K. W.—Too late to acknowledge last month.

W. H. GUNDRY.—Have sent copy of your two-mover. Your solutions arrived too late to acknowledge. Three-mover appears below.

OTTO SCHACHEL.—If 1. Q × Q, the Black Knight moves and will cover the threatened mate at KKt8.

W. PARKINSON.—If 1. Q to K5, Q to KKtsq, ch!

X. Y. Z.—The problem which you send is unfortunately too full of dual mates for publication. For instance the Knight can always mate at Q7 wherever the King goes, and even the threat is a double one. In fact Q × B and Q to Q7 are apparently the only defences free from resulting duals.

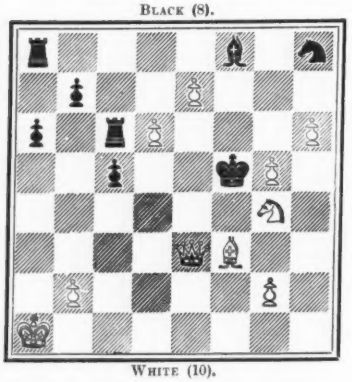
XUM

PROBLEMS.

No. 1.

By B. G. Laws.

BLACK (8).



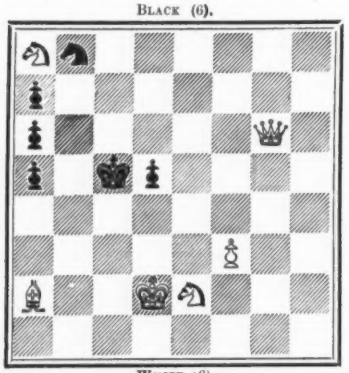
WHITE (10).

White mates in three moves.

No. 2.

By W. H. Gundry (Exeter).

BLACK (6).



WHITE (6).

White mates in three moves.

Mr. J. K. Macmeikan, of Repton School, honours me by the dedication of the following subtle stratagem:—*White*—K at QBsq, R at KR6, B at K5 and KB7, Kt at Q3 and QB6, P at KR3 and QB2. *Black*—K at QB6, R at Q5, P at KR4 and QR3. White compels Black to mate in seven moves.

CHESS INTELLIGENCE.

Mr. H. N. Pillsbury has beaten all records for blindfold play by engaging in 20 games simultaneously at the Franklin Chess Club, Philadelphia, on April 28th last. His score was—won 14, drawn 5, lost 1. Considering that his opponents included such well known players as S. W. Bampton, C. J. Newman, and W. P. Shipley, Mr. Pillsbury's performance must be regarded as brilliant in the extreme. Dr. Zukertort once played 16 games blindfold, but no other player, we believe, has played so many—certainly not more—till Mr. Pillsbury finally eclipsed all previous performances.

A correspondence match of two games is in progress between the Vienna Chess Club and the French Chess Association. The openings are the Four Knights Game and the French Defence. Mr. Steinitz has been playing his own gambit by correspondence with the Liverpool Chess Club, with the view of testing a new departure for White at move 9. Mr. Steinitz was mated on the 34th move.

The Paris international tournament has been making rather slow progress owing to the frequent holidays. The full score will be given next month. Messrs. Lasker and Pillsbury have been in fine form, but the latter lost to Mr. F. J. Marshall, the winner of the minor tournament in London. Mr. Marshall's play has so far been the feature of the meeting. The other players are Maroczy, Burn, Schlechter, Janowski, Tchigorin, Mason, Mieses, Marco, Mortimer, Brody, Showalter, Sterling, Didier, and Rosen. Mr. Blackburne was unfortunately prevented from entering owing to serious trouble with his eyes. Herr Marco is scoring uncommonly well, but Herr Schlechter is losing far more games than is usual with him. Janowski has had a bad time lately, but Mieses is still doing well. Herr Lasker holds the lead and is certain of the first prize.

The score of the following game is from *The Field*:—

WHITE. Schlechter.	BLACK. Showalter.
1. P to K4	1. P to K4
2. Kt to KB3	2. Kt to QB3
3. B to Kt5	3. Kt to B3
4. Castles	4. Kt takes P
5. P to Q4	5. Kt to Q3
6. B takes Kt	6. QP takes B
7. P takes P	7. Kt to B4
8. Q takes Qch	8. K takes Q
9. Kt to B3	9. P to KR3
10. R to Qch.	10. K to Ksq
11. P to QKt3	11. B to K3
12. B to Kt2	12. R to Qsq
13. Kt to K2	13. P to KKt4
14. P to KKt4	14. Kt to Kt2
15. P to KR3	15. B to K2
16. KKt to Q4	16. P to KR4
17. P to KB3	17. P to QR3
18. Kt to Kt3	18. P takes P
19. RP takes P	19. R to R5
20. K to Kt2	20. B to QBsq
21. KtQ4 to B5	21. B takes Kt
22. Kt takes B	22. Kt takes Kt
23. P takes Kt	23. B to B4
24. R takes Rch	24. K takes R
25. R to Ksq	25. R to KB5
26. P to B6	26. K to Q2
27. B to Bsq	27. R to B4
28. K to Kt3	28. K to K3
29. B to Kt2	29. P to QKt4
30. R to Qsq	30. B to K6
31. R to Q8	31. B to B5ch
32. K to Kt4	32. Resigns

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